ENGINEERING CONSTRUCTION WEEKLY

ENGINEERING NEWS-RECORD

FEBRUARY 29, 1940

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ENGINEERING NEWS-RECORD

Devoted to Buildings, Sewers, Waterworks, Bridges, Highways, Streets, Dams, Foundations, Earthwork, Flood Control, Public Works, Irrigation, Canals, Railroads

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THIS WEEK

● Culmination of a major editorial effort is realized in the 72-page section of this issue devoted to machinery and equipment at the 1940 Road Show in Chicago. Two *ENR* editors spent their Road Builders convention days in interviewing every exhibitor. At night they sat in smoky hotel rooms writing up what they had seen. Since then they have been sweating over layout and make-up, and finally putting their okay on the result which it is hoped merits the further okay of *ENR* readers.

● Los Angeles can spend a lot of money on engineering in the next few years, if it can get the money. Specifically sewerage and superhighways are the needs of the moment, and in this issue on pages 45 and 62 are presented the proposed plans for a comprehensive plan of relief for an overloaded trunk sewer, in which sewage now travels as much as 55 miles, and for a six-mile toll parkway, first unit of a quarter-billion-dollar traffic relief plan for the city.

● In the second of George H. Hall's articles on electric drive for construction machines, the selection of motors is discussed. *News-Record* has prepared a full-page drawing showing correct wiring and auxiliary apparatus diagrams for using different types of electric motors with different pieces of construction equipment.

● Rigid frame designers had a field day when they were given the problem of a viaduct approach to the Lincoln Tunnel at New York; they produced a structure that has seldom been equalled for variety of design expedients to meet special conditions. See p. 41.

THINGS TO COME

THE THIRD of a series of articles on divided highway design, to be published Mar. 14, will be the most complete summary of current practice in rural curb design ever made.

THE MISSISSIPPI soon will be spanned by another bridge, this time at Davenport, Ia. and Rock Island, Ill. Its tied arch span construction will be discussed in the next technical issue of *Engineering News-Record*.

10 DAYS plus $200 SAVED
with Atlas High-Early cement!
Preparing the foundation for the East Street Sludge Disposal Plant. Ten days' time and $200 curing expense was saved by using Atlas High-Early cement. Consulting Engineer, George B. Gascoigne, N. Y.; Acting Director, W. Vincent Barry, Dept. of Public Works, New Haven; Contractor, New Haven Road Construction Co., Inc.

How a contractor cut job time in half, saved $200 in curing costs, by using Atlas High-Early Cement!

THE JOB: To drive piles during the winter for the East Street Sludge Disposal Plant, New Haven, Conn.

THE PROBLEM: After driving pile shells and filling with concrete, the contractor could not drive additional piles nearby until the newly placed concrete gained enough strength to withstand vibration. Naturally, this tie-up would have meant time and money lost.

THE SOLUTION: The contractor decided to use Atlas High-Early cement. He placed concrete, made with Atlas High-Early, in the driven shells at the end of the day. Result! This concrete gained such strength overnight that the contractor could drive piles close by—*the next day!* Thus, he estimates, the use of Atlas High-Early saved 10 days on an otherwise 20-day job . . . and—in addition—saved $20 a day—or $200—on curing costs!

A SAVING LIKE THIS on time and curing costs usually pays over and over again for the slightly higher cost of Atlas High-Early cement. If you want to see how this easily workable, fast-setting cement can help you rush through rush jobs . . . and how it can help you cut costs on many types of concreting work, try it out on your *next* job! Universal Atlas Cement Co. (United States Steel Corporation Subsidiary), Chrysler Building, New York City.

NR-H-8

Atlas High-Early Cement

A UNIVERSAL ATLAS PRODUCT

ENGINEERING NEWS-RECORD

NEWS

Volume 124 FEBRUARY 29, 1940 Number 9

House Refuses Funds For Panama Locks

Committee approves appropriations close to budget figures for rivers and harbors work

The House appropriations committee refused this week to approve immediate construction of the $227,000,000 third set of locks at the Panama Canal. The budget had recommended an appropriation of $15,000,000 plus an authorization to incur obligations of $99,000,000 to start work on the project; although the locks won't be needed commercially until 1960 it was asserted that they were urgently needed for military reasons.

The appropriations committee, however, in reporting out the War Department civil functions appropriations bill, refused to agree that a project taking six years to complete could have urgent defense importance, and said that the project was being pushed too rapidly. It recommended an appropriation of $850,000 to continue design studies.

On most other points, the committee held closely to the budget figures, which are themselves well below current appropriations for rivers and harbors. A total of $66,721,000 was appoved, of which $24,300,000 is for new construction. This includes only one new project, the deepening of the Delaware River.

A proposed harbor at Wake Island was in the budget, but the committee threw out the $700,000 for this purpose. For general flood control $70,000,000 is approved, and for Mississippi flood control there is $30,000,000 while $600,000 is provided for the Sacramento project.

The committee recommends $2,000,000 for installation of power at Fort Peck Dam and $800,000 for Bonneville power. Also approved is $19,000,000 for continuation of protective works at the Panama Canal, to which is added contract authorization of $4,500,000.

POLHEMUS MADE PRESIDENT OF PORTLAND GENERAL ELECTRIC

JAMES H. POLHEMUS, for the past four years executive vice-president of Portland Electric Power Co. and its affiliates, Portland General Electric and Portland Traction, has been elected president of the Portland General Electric Co. Following his graduation from Stanford University in 1911 with a civil engineering degree, Polhemus worked with the U. S. Engineers as field engineer and superintendent of construction. In 1920 he was elected general manager and chief engineer of the Port of Portland, retiring in 1936 to go with Portland Electric Power.

Ontario Construction Reduced for Next Year

Ontario's budget for the coming fiscal year, which starts April 1, has been reduced by over $13,000,000, most of this reduction being represented by curtailed construction. Highway construction alone has been reduced from $15,000,000 to $7,000,000 the latter sum to be mainly for the completion of contracts already let.

Congress May Change Wage-Hour Law

Would exempt employees earning more than $200 monthly; professional definition unchanged

An amendment to the wage-hour law exempting all employees earning more than $200 per month from the hours provisions was introduced into Congress this week by Representative Charles Kramer. It is regarded as unlikely, however, that any immediate action will be taken since Congressional advocates of amendment of the act have agreed to give Administrator Fleming a chance to make some changes through redefinition of the exemptions. There will probably be no change in the definition of a professional, but the definitions of administrative and executive employees may be so broadened—perhaps by including all above a certain wage level—as to exempt most engineering employees.

Almost a year and a half after the act went into effect, the status of engi-

(*Continued on p.* 28)

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Southwest Road and Farm Show Attracts Big Group

The thirteenth annual Southwest Road Show and School, held jointly at Wichita, Kan., with the thirty-seventh annual Western Tractor and Power Farm Equipment Show, broke attendance records when a crowd estimated at from 190,000 to 200,000 visited the show on the four days of Feb. 21–24 to inspect $2,000,000,000 worth of equipment displayed by 150 manufacturers. The highlight of the show was the engineers' banquet Feb. 21 when 200 representatives of the highway departments of the Southwest participated. Widening of two-lane highways and building for safety were two matters that received a great deal of attention in the technical sessions during the show.

Lincoln Foundation Plans Welding Award Program

A 2½ year program of welding studies, which will culminate in the payment of $200,000 in awards, is planned by The James F. Lincoln Arc Welding Foundation, Cleveland, Ohio. A total of 458 awards are established for studies of welding that offer social, economic or commercial benefits, such as reduction or elimination of hazards to safety and health, greater availability of comforts and conveniences through reduced prices, and greater utility and durability of machines and structures.

The awards, ranging from $13,700 to $100, embraces the following classifications: automotive, aircraft, railroad, water craft, structural, furniture and fixtures, commercial welding, containers, welderies, functional machinery, industry machinery, and maintenance. The structural classification is divided into buildings and similar structures, bridges, houses, and miscellaneous. The welderies class includes commercial welderies and plant welderies.

To be eligible an author must have engaged in the design or execution of the work upon which his paper is based.

• • •

Public Housing Bonds Sold To Private Bidders

A high point in the initial steps of a private financing program for public housing was reached a few days ago when the first local housing authority long-term bonds, totaling $1,681,000, were sold on the open market to private bidders at a rate of interest from ½ to 1 per cent less than that required by USHA for its loans. The most significant fact about the sale, according to USHA officials, is that for the first time local housing authorities have demonstrated the ability to raise from private sources 20 to 25 per cent of the capital cost of public housing projects. This is in contrast to past experience when the USHA loaned 90 per cent of the cost with local communities supplying the remainder.

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U. S. Seeks to Have Utah Rebuild Old Highways

The Utah State Road Commission has been notified by the Public Roads Administration that about 200 miles of federal aid highways in Utah are in substandard condition and should be reconstructed at an early date. The work is estimated to cost $6,380,000, according to the PRA.

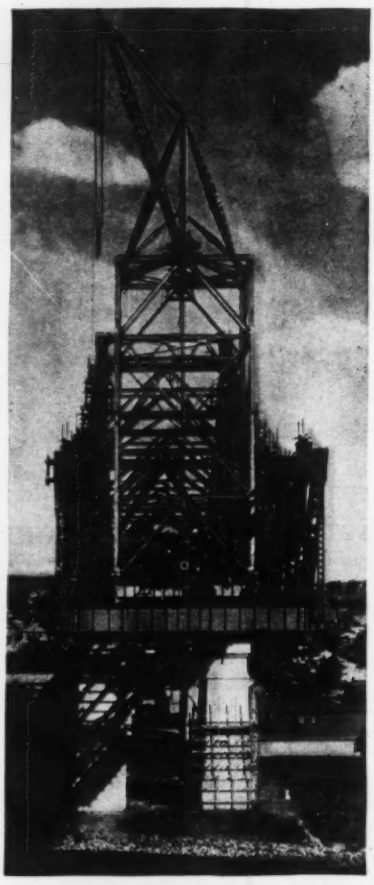
W. D. Hammond, chairman of the road commission, has pointed out that state engineers are well aware of the situation and under the present policy of starting at populous centers of the state and rebuilding outward the substandard sections will all receive attention in due course. He estimates the cost as at least $15,000,000.

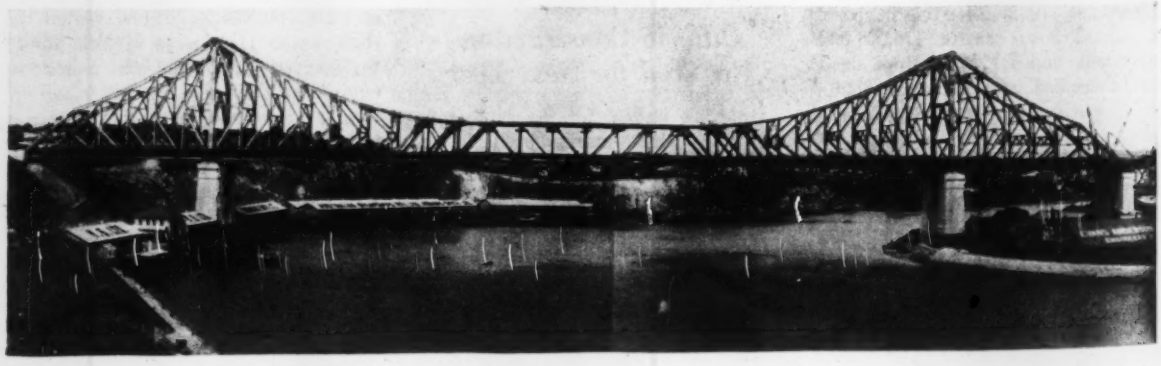
NEW BRIDGE IN BRISBANE; IT'S THE SECOND LARGEST IN AUSTRALIA

EXCEEDED in size only by the great steel arch at Sydney, the new cantilever across the Brisbane River at Kangaroo Point in Brisbane is Australia's newest bridge. Known as Story Bridge (after the present public service commissioner) it has a main span of 924 ft., including a 308-ft. suspended span, and anchor spans of 270 ft. It accommodates a 66-ft. concrete roadway and provides a 100-ft. clearance for shipping. Among its structural features are: the use of K-bracing (except in the suspended span) to provide an open appearance, ease in erection, and freedom from secondary stresses; pin connections of floorbeams to trusses; and a five-pin connection link at the top of the main posts.

No falsework was used in erection. A 200-ton deck traveler consisting of a 90-ft. steel tower, mounting a 40-ton derrick in front and an 8-ton derrick in the rear, placed all of the steel except the suspended span which was assembled by two lighter traveler derricks. According to James A. Holt, supervising engineer of design and construction, designs were begun in 1934 under the direction of J. J. C. Bradfield, consulting engineer to the Queensland Bureau of Industry, builder of the bridge, and contract was awarded to Evans Deakin, Hornibrook Construction Pty., Ltd., April 30, 1935. The bridge will be opened to traffic in June of this year.

An extensive paper on the bridge by Holt has been published by the Institution of Engineers, Australia, with offices in Sydney.





Georgia Ruling Prevents Pipeline Crossing Highway

The Georgia State Highway Department has the power to allow or deny the Southeastern Pipeline Co. the right to build a pipeline across state highways, according to a ruling of the state attorney general. The decision was handed down in a controversy as to construction of a pipeline from Port St. Joe, Fla., to Chattanooga, Tenn., construction having proceeded to Seminole County, southwest Georgia, where a state highway was to be crossed.

Several railroads have obtained injunctions against the pipeline company; the company has started a $450,000 damage suit.

• • •

Municipal Official Resigns To Avoid Political Levy

Imposition of a 4 per cent levy for support of a political party has impelled Carl V. Erickson, manager of the Urbana-Champaign (Ill.) Sanitary District, to tender his resignation. As a result some 22 engineering, technical, civic and social organizations in these university towns have held indignation meetings and formulated protest resolutions. The organizations are also attempting to induce the trustees of the Sanitary District, whose main function is the operation of a well-designed and up to now well-operated sewage treatment works, to refuse to accept the resignation but enter into a contract whereby political considerations will not be a factor, political qualifications unnecessary and political duties nil.

The Central Illinois Section, Am. Soc.C.E. through its representative, T. C. Shedd of the University of Illinois and chairman of the committee representing the combined 22 organizations, including the local section of the Illinois Society of Engineers, at its meeting Feb. 21 in Urbana approved the condemnatory resolutions of its board of directors.

The real difficulty is stated to arise from the desire on the part of one of the three trustees to assume the managership. A proposal of the trustees that Erickson accept a raise in salary if Erickson would donate part of the raise to the party was also refused by him.

• • •

Right-of-way Obtained For Blue Ridge Parkway

Final obstacle to a right-of-way for the Blue Ridge Parkway through the Cherokee Indian reservation in western North Carolina was removed Feb. 10 when the Cherokee tribe voted to grant land for a right-of-way for the road, the vote ending the attempt since 1935 by the state to obtain the necessary land for the road.

LOS ANGELES MEMORIAL WILL HONOR WILLIAM MULHOLLAND

A PERMANENT STRUCTURE dedicated as a memorial to the late William Mulholland, builder of the Los Angeles Aqueduct, is to be erected in Los Angeles with funds raised by popular subscription. The city has set aside a piece of land at Riverside Drive and Los Feliz Blvd. and on this is to be built an illuminated fountain that will play constantly with changing streams of water and changing colors.

Upper parts of the fountain will be formed by 134 small jets and at the base eight 6-in. ports will give volume to the flow over concentric circular falls. The fountain will play day and night without waste of water as the flow will be part of the city's supply, protected from contamination by a surrounding pool of still water. The project, including landscaping but not purchase of the land, is to cost about $35,000.

WASHINGTON HIGHLIGHTS

Special reports by Paul Wooton

THE SPEND-LEND bill killed by the House last summer is brought up again, in limited form, by bills introduced by Representatives Rankin and Starnes. Starnes' bill would empower the Federal Works Administrator to loan $300,000,000 to public and non-profit bodies for construction of hospitals, water and sewage treatment plants, and for stream pollution control. Loans would be for fifty years at 2 per cent interest. Rep. Starnes made several unsuccessful attempts last year to put through a new PWA program. The Rankin bill would appropriate $100,000,000 to be loaned by the works administrator to public bodies for the construction or improvement of power distribution or generating facilities. Rep. Rankin is the House's leading advocate of public power, but the bill is given little chance of passage, both because of the current economy drive and because both houses went on record last year as opposed to competitive public power plants.

THREE YEARS ago Congress approved a three-year program of studies of materials for low-cost housing, to be made by the Bureau of Standards and to cost $200,000 a year. To date, reports have been published on eighteen new constructions. Procedure followed was to invite manufacturers to submit samples of their product in the form of complete wall, floor, roof or partition sections to be tested for structural, insulating and fire-resisting qualities.

Now the approaching end of the three-year research program has precipitated a vigorous argument among federal housing agencies as to what use shall be made of the results so far achieved and what direction further studies ought to take. Although the Bureau of Standards comes under the Department of Commerce, most of the guidance of the program has come from outside the department through the Central Housing Committee—an unofficial organization of housing agency representatives which has opposed plans of the Commerce Department to use the test information in promoting $2,500 homes.

Everybody, however, wants the research continued in some form or other, and the housing agencies have now agreed to ask Congress for permission to assign part of their funds to the Bureau of Standards—thus keeping the program under the thumb of the Central Housing Committee.

Wage-Hour Law

(Continued from p. 25)

neering and construction employees is still in considerable doubt. In determining whether employees of an engineering office come under the act two questions have to be answered: whether the employee is a professional; and whether the work done is in interstate commerce. As regards the first point, the wage hour administration has consistently refused to make rulings. It answers inquiries simply by quoting the definition of professional given in section 541.2, Title 29, Chapter V of the Code of Federal Regulations, leaving it up to the employer to decide, and warning him that if he guesses wrong he can be sued.

What is interstate engineering?

The question as to what engineering work is interstate commerce is very complicated. It has been held that plans and drawings are "goods," and therefore an office making designs in one state for a job in another is engaged in interstate commerce. If the not uncommon practice of setting up a branch at the site of the job is followed, it is probably not interstate commerce—provided *all* the work is done at the branch office. The nature of the structure being designed also enters in. Engineering work on the repair or enlargement of a factory engaged in interstate commerce is in interstate commerce. If, however, the work is on a new factory which will engage in interstate commerce, the engineering is not interstate commerce.

Similarly, designs for the construction of a highway over an entirely new right of way is not interstate commerce, but design of a six-lane concrete road along the right of way of a two-lane dirt road is. The same holds for railways, bridges, and pipelines.

Substantially the same reasoning applies to construction. Construction, in itself, is not interstate commerce even though materials from outside the state are used. But if the work consists in the repair or enlargement of a structure being used in interstate commerce or in the improvement of an existing road, railway, or pipeline, then construction is interstate commerce and is covered by the act.

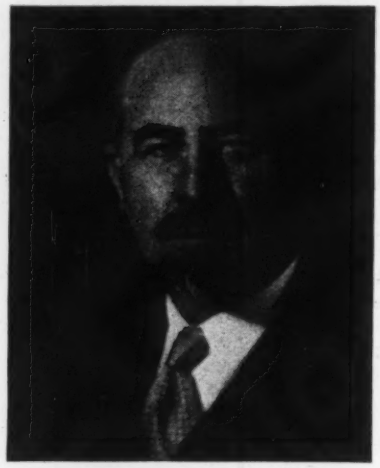
• • •

Barge Damages Bridge In North Carolina

A barge, breaking loose from its moorings during a storm, Feb. 26, ripped out a 17-ft. span of Wright Memorial Bridge across Currituck Sound, N. C. Three other spans were damaged.

Dorr Receives National Modern Pioneers Award

John Van Nostrand Dorr, president of The Dorr Co. and associated firms was among the American inventors and research scientists honored Feb. 27 with



JOHN V. N. DORR

Modern Pioneer Awards by the National Association of Manufacturers. Dorr was given the award for his work in chemical, metallurgical and industrial engineering. Benefits to public health resulting from his work in municipal sewage and water treatment were cited.

Dorr equipment and processes, it was pointed out, are used for the treatment of about three billion gallons a day of domestic sewage and water, a population of 30,000,000 being affected.

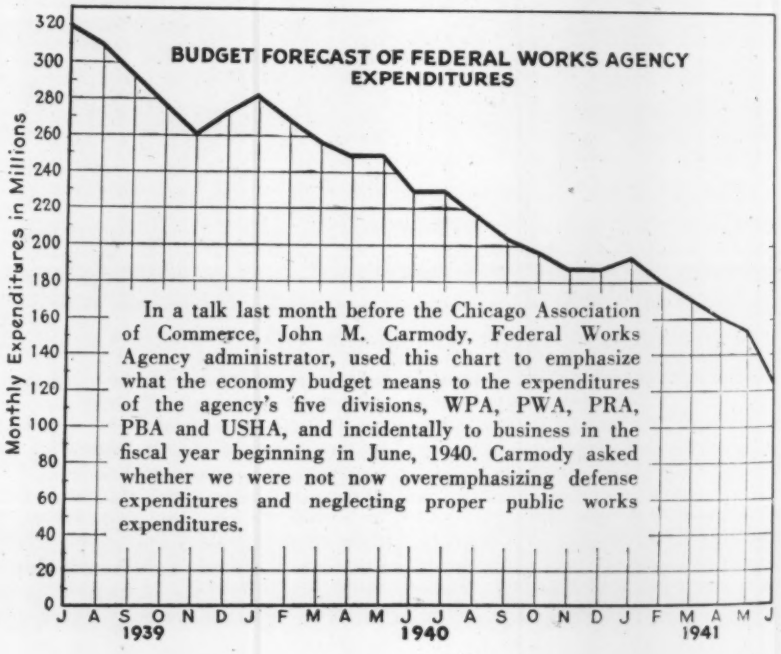
Lumber Grade Marking In Anti-Trust Suit

The building anti-trust case brought in New Orleans by the Department of Justice includes a charge that the Southern Pine Association restrained trade by the use of a lumber grading and inspection system. This does not imply, however, that the department considers grading in itself an illegal activity for a trade association. Just as in the case of labor union indictments, the department believes that the Southern Pine Association used a legal activity for an illegal purpose. The illegality lay in the alleged attempts of the association to prevent adoption of any other grading systems through its control of local groups and through lobbying at the Commerce Department which approves grading systems. Also, it is charged, the association collected an unreasonably large fee for grading lumber of non-members and used advertising asserting that ungraded lumber was inferior. The association has entered a plea of no defense.

• • •

Missouri Road Fund Increased by $3,000,000

The state of Missouri will have $3,000,000 more for new road construction this year than last, or an increase from $7,522,000 in 1939 to $10,950,000 in 1940, according to the state highway commission. The increase is due to an upturn in revenue coupled with the fact that some uncommitted funds are available.



In a talk last month before the Chicago Association of Commerce, John M. Carmody, Federal Works Agency administrator, used this chart to emphasize what the economy budget means to the expenditures of the agency's five divisions, WPA, PWA, PRA, PBA and USHA, and incidentally to business in the fiscal year beginning in June, 1940. Carmody asked whether we were not now overemphasizing defense expenditures and neglecting proper public works expenditures.

Survey Reveals Wide Use Of 20,000 lb. Unit Stress

The 20,000 lb. unit stress limit in steel construction has now been adopted in the building codes of 203 American cities, according to the American Institute of Steel Construction, which in 1936 recommended such a standard specification. In addition 148 other cities permit the use of this stress without so specifying it in their codes.

This stress is also allowed by the following state and public bodies: Alabama State Department of Public Works; American Railway Engineering Association; Civil Aeronautics Authority; California State Chamber of Commerce; California State Commission for the Golden Gate International Exposition; Bureau of Architecture of the California State Department of Public Works; F.H.A. for Northern California; Massachusetts Department of Public Safety; National Board of Fire Underwriters; National Park Service; Division of Architecture of the New York State Department of Public Works; New York World's Fair; Department of Public Works of North Carolina; Ohio State Department of Industrial Relations; Ohio Board of Building Standards; Pacific Coast Building Officials Conference; General State Authority of Pennsylvania; Sanitary District of Chicago, and South Carolina State Department of Public Works.

Chicago, Boston, New York and Philadelphia still require that the 18,000 lb. unit stress be used.

• • •

Bids Asked for Columbia Flood Control Work

First steps in the $8,170,000 Columbia River flood control work for 1940 were taken Feb. 21 when bids were asked for 2,100,000 cu.yd. of dike earthwork and for the construction of 1,010 lin.ft. of pile and stone dikes as part of 13 miles of levee embankment and appurtenant works in the Sauvies Island drainage district near Portland. Bids for the dike earthwork will be opened March 20 and those for the second job March 13. Bids are also to be called within 30 days for a drainage pumping plant and tide boxes, all of the work totaling between $1,000,000 and $1,600,000.

The 13 miles of embankment will be placed along the southerly end of Sauvies Island at the confluence of the Columbia and Willamette rivers and Multnomah slough to protect 11,000 acres of low-lying land.

Chicago Superhighway Financing Unconstitutional

On a test case to determine the legality of the financial method by which Chicago and Cook County proposed to provide funds to build a comprehensive system of superhighways the Illinois Supreme Court Feb. 21 held unconstitutional the legislation authorizing the county and city to utilize half their gas tax funds to service the bonds.

The law required filing of plans with the state highway department by March 1. The county had already filed plans for a $40,000,000 route to the northwest and the city has completed plans for a route costing $36,000,000 to the west along Congress Street. Plans for the latter are required to be filed with PWA to comply with the contract by which the subway grant was obtained.

The adverse decision held that the motor fuel excise is a tax and not a service charge such as is collected for water which could be used to service a revenue bond. In other words, gas tax anticipation warrants are not constitutional in Illinois.

Since the county has large unexercised bonding power it can issue faith and credit bonds after submitting the issue to referendum. The city has too little bonding power to raise money in this way.

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Winners Announced In Bridge Design Contest

Grant W. Voorhees, Iowa State College, won the first prize of $200 in the contest sponsored by the American Institute of Steel Construction for the best design by college students of a steel pedestrian bridge overpassing a vehicular express highway. Vincent W. SeeBach, New York University, won the second prize of $100, and Mae G. Greene, New York University, won the third prize of $50. Eighty-four students from 13 colleges participated in the competition, which is held anually.

Students receiving certificates of honorable mention were: Manrico Marzi, New York University; T. A. Russ and E. I. Freeborn, both of Texas A. & M.; Donald R. Brown, University of Illinois; Will A. Thomas, University of Oklahoma; C. E. Rothrrock, Virginia Polytechnic Institute, and Myron E. Jensen, Iowa State College.

Judges were: Homer R. Seely, deputy commissioner for the department of public works, New York City; William H. Nathan, chief engineer, department of parks, New York City; Frederic C. Hirons, New York architect; Alfred Easton Poor, New York architect, and Kenneth Reid, editor of *Pencil Points*.

Oklahoma Threatens Grand River Project

Governor may call out national guard unless payment is made for roads

Governor Leon Phillips of Oklahoma this week threatened to call out the national guard to halt work on the Grand River project if the Grand River Dam Authority fails to pay the state $850,000 which the governor claims is due in payment for roads to be inundated by the authority's Pensacola Dam. The authority, a state agency, is building the dam and power plant with a PWA loan and grant; PWA has refused to permit payment of the claim.

In a letter to the governor last week, Federal Works Administrator Carmody asserted that an agreement had been made between the authority and the previous state administration that construction by the authority of a $350,000 bridge now completed would be accepted as full payment of the inundation claims.

Governor Phillips also recently threatened to use the national guard to stop work on the U. S. Engineers Denison Dam project on the Red River, but the threat has not yet been carried out.

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American Firms to Aid Greek Power Scheme

American engineering and construction firms are to participate in a water power and development scheme that has just been approved by the Greek government, provided funds to finance the work can be obtained in this country. Under an agreement between the government of Greece and the Hellenic Hydro-Electric and Metallurgical Corp., New York, the latter company is granted authority to exploit the water power resources of the Acheloos River and to use the power to develop the natural resources of the region.

A study of the power possibilities of the river was made some time ago by the firm of Hugh L. Cooper & Co. under a contract made by Hugh Cooper before his death. If the present scheme goes through, Hugh L. Cooper & Co. will do the engineering work in connection with power and the Chemical Construction Corp., New York, a subsidiary of the American Cyanamid Co., will do the industrial engineering work.

Three power developments and a river regulating reservoir are included.

OBITUARY

A. F. BLAESS, 69, who retired in 1938 as chief engineer of the Illinois Central R.R., died last week in Gulfport, Miss. Blaess, a civil engineering graduate of the University of Michigan with the class of 1895, began his railroad work as track apprentice with the Illinois Central in 1897 and became chief engineer in 1925.

SAMUEL H. SHEARER, 82, former city engineer of Indianapolis, Ind., and former chief engineer of the State of Indiana during the administration of Governors Porter and Gray, died in Indianapolis Feb. 20. In 1895 Shearer joined the Western Paving & Supply Co., Indianapolis. In representing that company he traveled extensively in all parts of the world. He was a graduate of Northwestern Christian University.

GEORGE H. CUSHMAN, 85, one of the founders of the Cushman-Fairleigh Engineering Co., Chattanooga, Tenn., died Feb. 23 in that city. Cushman, a graduate of Troy Polytechnic Institute in 1879, entered the construction field in New York City, going to Chattanooga in 1881.

KNOX T. THOMAS, consulting engineer of Atlanta, Ga., died Feb. 22 in that city. Thomas began his engineering work as a hydrographer in the Southeast for the firm of Hall Brothers, district hydrographers for the U. S. Geological Survey. He also worked for a time as construction engineer for the Gulf & Ship Island R.R., the Louisville & Nashville R.R., and the Virginia & South Western R.R. Before establishment of the Georgia State Highway Department, Thomas served as state highway project engineer.

SAMUEL E. BARNEY, 81, professor emeritus of civil engineering at Yale University, died in New Haven Feb. 23. Following graduation from the Sheffield Scientific School in 1879, Barney was employed by the Burlington & Missouri River and the Union Pacific railroads. He also worked for the Denver & South Park R.R. and the Colorado Central R.R. In 1883 he returned to Yale University as a member of the civil engineering faculty, retiring in 1924.

E. CLARK COWDEN, 60, city engineer of Harrisburg, Pa., for the past 14 years, died in that city Feb. 21. Cowden succeeded his father in 1926 as city engineer. Prior to that he served as consulting engineer in the Pennsylvania State Bureau of Municipalities. He was also employed for a time by the Barber Asphalt Paving Co. Since 1914 he had been secretary of the Harrisburg city planning commission.

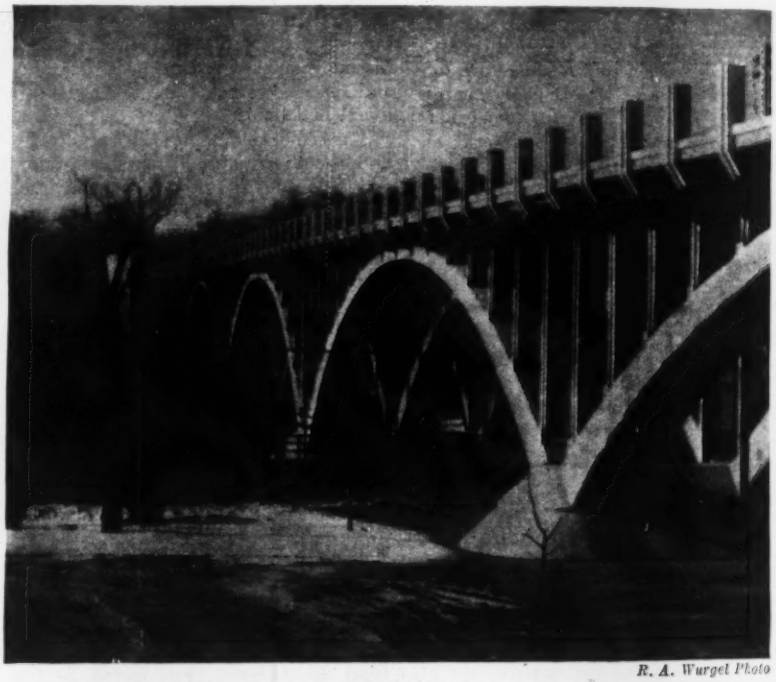
CHARLES HOSFORD, 73, Minnesota road contractor formerly associated with the firm of Engstrom & Hosford, Northfield, died recently at his home in Burtrum, Minn.

Other recent deaths include: EDWARD H. TURNER, 60, deputy city engineer of Youngstown, Ohio; ROBERT SCHWANBECK, 69, engineer and manager of the Ash Fork, Ariz., waterworks; K. C. BOND, building contractor of Hamilton, Ont.; ROBERT PRICE, general contractor of Pipestone, Minn.; JOSEPH LIND, 72, pioneer Minnesota contractor of Cambridge, Minn.; CHARLES M. KERR, 73, president of the York Water Co., York, Pa., Wrightsville, Pa.; WILLIAM D. BROOKS, 72, veteran contractor of Middletown, Pa.; ELLIS SAUCIER, 59, building contractor of Gulfport, Miss.; GEORGE A. BRYCE, 76, builder of early irrigation structures in the Gila River Valley, Bryce, Ariz.; JEREMIAH J. HIGGINS, 82, builder of Worcester, Mass.; ALBERT J. AMY, 52, contractor of Opelousas, La., and JAMES A. TRICKETT, 82, building contractor of Washington, N. C.

• • •

Mississippi Bridge Planned For Below St. Louis

Bonds are soon to be issued for a toll bridge to span the Mississippi River below St. Louis between Jefferson Barracks in St. Louis County and Monroe County, Ill. The structure is estimated to cost between $2,500,000 and $3,500,000. Sverdrup & Parcel, St. Louis, are acting as engineers.



R. A. Wurgel Photo

NEW LINK IN WESTCHESTER COUNTY PARKWAY SYSTEM

TRAFFIC CONGESTION at an old, narrow bridge on Westchester (N. Y.) County's Cross-County Parkway will be relieved soon when the new Fleetwood Viaduct arch bridge, shown above, is put into service.

The Cross-County Parkway is an east-west artery connecting the lower ends of Sawmill River Parkway and Hutchinson River Parkway. The Sawmill River route is a link between New York City and upstate points, while the latter parkway is a connection to New England.

The new bridge, which crosses the Bronx River Parkway, the Bronx River and the New York Central Ry., is a 4-lane roadway supported on four reinforced concrete arch spans varying from 117 to 133 ft. in length. Total length is 780 ft. Work is being financed as a self-liquidating toll project. As soon as toll collection equipment is installed, the bridge will be opened to traffic.

The bridge is a project of the Westchester County Parkway Commission. The arch section contractor was Foley Bros., Inc., Pleasantville, N. Y., and the Bronx Water Works Corp., New York City, built the trestle approach section.

Oklahoma City Votes Money for Waterworks

By a vote of 7,576 to 7,185, residents of Oklahoma City Feb. 20 approved the expenditure of $6,911,000 for improvement of the city's waterworks system. The approved work, known as the Upper Bluff Creek project, calls for water to be taken from the North Canadian River and stored in a 75,000 acre-ft. reservoir, construction of a new filter plant, a pumping station and 37 miles of mains. It is estimated that the construction time required for the work will be about two years.

The election ends a campaign of many years duration for a new water supply for Oklahoma City. Drought has made the situation acute, the present supply having been reduced such that only a 60-day supply remains. As a result, emergency wells are now being drilled to meet the present shortage (*ENR*, Feb. 8, 1940, p. 209). It may also be necessary to ration water if no rain is received soon.

CONTRACTS AND CAPITAL

ENGINEERING construction awards for the short week due to the Washington's Birthday holiday total $59,094,000. This compares with $52,980,000 for a week ago, and $85,605,000 for the corresponding 1939 week.

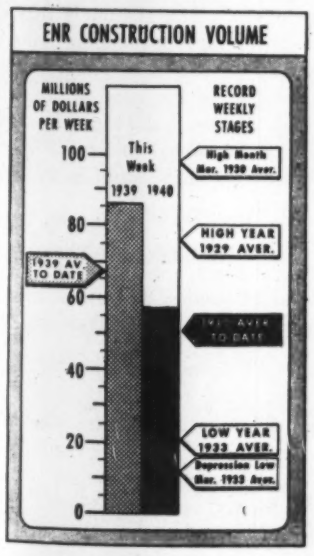
The current week's volume brings 1940 construction to $462,905,000, a level 23 per cent below the total for the 9-week period last year. Private awards for the period, however, are 9 per cent higher than a year ago.

Private awards for the week reach $11,644,000 compared with the $17,865,000 volume reported for a week ago and $23,377,000 for the 1939 week. Public construction for the current week totals $47,450,000 as against $35,115,000 for last week and $62,228,000 for last year.

Highway volume for the week reached the highest level since April 13, 1939 primarily as a result of the $13,700,000 WPA secondary road improvement program in Ohio. In addition to streets and roads, commercial building and large-scale private housing, waterworks, and public buildings topped their last week's volumes; and public buildings and earthwork and drainage exceeded last year.

New capital for construction purposes for the week totals $11,748,000, an increase of 51 per cent over the volume reported for the corresponding 1939 week. The current week's volume is made up of $7,787,000 in state and municipal bonds, and $3,961,000 in corporate security issues.

New construction financing for the year to date, $176,453,000, is 59 per cent below the $434,236,000 reported for the 9-week period last year.



CONTRACTS

(Thousands of dollars)

	Week Ending Mar. 2 1939	Feb. 22 1940	Feb. 29 1940
Federal	$1,345	$6,019	$8,714
State & Municipal	60,883	29,096	38,736
Total public...	$62,228	$35,115	$47,450
Total private..	23,377	17,865	11,644
TOTALS	$85,605	$52,980	$59,094
Cumulative 1940 .....(9 weeks).....			$462,905
1939 .....(9 weeks).....			$601,141

Note: Minimum size projects included are: Waterworks and waterways projects, $15,000; other public works, $25,000; industrial building, $40,000; other buildings, $150,000.

NEW PRODUCTIVE CAPITAL

	Cumulative 1939 9 Wks.	1940 9 Wks.
NON-FEDERAL ...	$160,736	$176,453
Corp. securities..	31,387	32,175
State & Mun....	113,673	82,931
R.E.A. loans.....	15,631	.....
U.S.H.A. loans...	.....	60,786
R.F.C. loans.....	45	561
FEDERAL	$273,500	$.....
TOTAL CAPITAL..	$434,236	$176,453

FHA MORTGAGES

	Week Ending Feb. 25 1939	Feb. 17 1940	Feb. 24 1940
Selected for appraisal $21,426		$19,487	$18,352*
Cumulative 1940 .....(8 weeks).....			$134,378*
1939 .....(8 weeks).....			$151,679

* Subject to revision.

ENR INDEX NUMBERS

Index Base = 100		1913	1926
Construction Cost	Feb., '40..	238.32	114.56
Building Cost	Feb., '40..	201.50	108.93
Volume	Jan., '40..	173	76

BRIEF NEWS

HIGHWAY CONSTRUCTION and improvements totaling $4,000,000 are proposed for 1940 in North Dakota following a decision of the state supreme court upholding the additional one-cent gas tax, proceeds of which are earmarked for road building. This program represents an increase of more than $1,000,000 over the minimum $3,000,000 announced previously, according to J. S. Lamb, state highway commissioner.

A BILL has been signed by the governor of the state of New York for the consolidation of the Triborough Bridge Authority and the New York City Parkway Authority. The bill is aimed to pool revenues from the bridges now under operation and to use the surplus funds to finance additional toll projects in New York City. Robert Moses, now head of both organizations, will be head of the new body.

WITH $1,840,000 having been received in tolls since the Evansville-Henderson Bridge spanning the Ohio River was opened, the structure is scheduled to become toll free in October. Collection of tolls was begun in July 1932 and but $207,000 of bonded debt remains against the structure.

• • •

House Approves Spending For Construction Work

Expenditure between now and July of $15,517,000 to continue work at full speed on four reclamation projects and a harbor job was approved by the House this week when it passed and sent to the Senate the first deficiency bill. The same bill appropriated $5,000,000 over solid Republican opposition to carry out a census of housing this spring in conjunction with the regular decennial population census.

To get essential work done at Grand Coulee before high water in July, $7,000,000 is appropriated, a million less than was approved by the budget bureau. For Central Valley, $5,000,000 is appropriated to permit continuation of the present rapid pace; this also is a million under the budget. For construction of power lines at the Rio Grande project, now nearly completed, $1,017,000 is provided. And for additional generating capacity at Boulder Dam, necessitated by the expanding market, $1,000,000. Enlargement of San Diego Harbor, which has been going forward at a rather leisurely pace, is to be accelerated by the appropriation of $1,500,000, a half million under the budget. This harbor is an important navy base.

COMMENT AND DISCUSSION

Readers' opinions on matters that concern the engineer

Rubber Waterstops

Sir: In the article on rubber waterstops for dams in your issue of Feb. 6, p. 159, neoprene and "DuPrene" are mentioned as though they were different products. Neoprene is the same material that was formerly sold under the trade mark "DuPrene." Neoprene is a generic term that does not need to be capitalized.

S. J. DALY
Advertising Manager
Rubber Chemicals Division
E. I. DuPont de Nemours & Co.

Jobs For PWA Engineers

Sir: In behalf of my associates and the splendid body of engineers who are likely to be assisted through the editorial "Engineers and Industry" (*ENR*, Feb. 1, 1940) I want to thank you. I can think of no more effective medium to bring these trained engineers and potential employers together than your journal. They all read it. Each knows the problems of the other. Experience and training have developed mutual understanding and respect. I am sure PWA engineers appreciate the trouble you have gone to to express a genuine interest in their desire to secure permanent employment.

JOHN M. CARMODY
Administrator
Federal Works Agency

Sir: Referring to your editorial "Engineers and Industry" of Feb. 1, 1940, commending the action of the Federal Public Works Administration to assist their furloughed engineers: This plan should be endorsed by all engineers, providing the inequalities of employment classification with PWA are adjusted according to experience, qualification and ability.

Referrals to industry should be on the above basis, rather than the basis on which they were employed under the PWA, which has been in many cases political. In other cases, men of major ability have been forced to accept employment with PWA under minor classification, by reason of the emergency caused by unemployment.

Unless such a course is followed, the whole thing will be an injustice to both the engineers and industry alike, and should be put in the category of politics.

H. R. GRABURN
Professional Engineer
Utica, N. Y.

Reemployment file data on the qualifications and service of engineers released by the PWA cover the full professional record of the men in question, prepared by themselves, and not merely their positions and service with PWA. These data are contained in complete record sheets, which have been indexed and classified to permit of ready selection of any particular type of experience qualification.—EDITOR.

A Plea For Clear English

Sir: After what has been written during the past twenty years on "English for Engineers" it may seem superfluous to add more to the subject. Yet the need for clearness in expression was never greater than it is at present.

The English used by an engineer should be both clear and correct. The Committee on Standardization of Technical Nomenclature of the Society for the Promotion of Engineering Education once sent a questionnaire to a hundred engineers, teachers, writers and publishers in which stress was given to their use of the hyphen and compound words. "The differences of opinion shown by the data were amazing," says Prof. John T. Faig, the chairman of the committee.

I once asked Prof. Thomas Nolan, the editor-in-chief of *Kidders Handbook for Architects and Builders*, how he, himself, used the hyphen. He replied that in compound words he followed the system recommended by the Standard Dictionary. He further wrote, "We don't put hyphens between nouns and the adjectives which qualify them. In the expression 'steel-contractor', steel is a noun and not an adjective. It is a short way of saying 'the contractor for the steel'. Again, we write 'dead load', 'live load', 'wind-load'. The words 'dead' and 'live' are adjectives, but the word 'wind' is a noun. The wind-load is caused by the wind but the dead load is not caused by the dead."

"Words outgrow hyphenation." As they become familiar the hyphen is dropped.

Inelegance of expression, however, may be forgiven sooner than ambiguity of language. Most of the trouble between owners, engineers and contractors is due to the neglect of writers of specifications to express themselves clearly. Here let it be noted that a sentence can be made ambiguous by the use of unnecessary words as well as by employing words with more than one meaning. "An example frequently met is 'necessary or required' in such clauses as 'The Contractor shall provide all bracing and shoring necessary or required in connection with the work'. This might be taken to mean that the architect reserved the privilege of requiring the contractor to do more shoring or bracing than necessary. In fact it is difficult at times to determine just what is meant by the use of both words." (H. W. Bach, *Pencil Points*, August, 1927.)

Sometimes too few words are used. One who took part (F. L. Castleman, Jr., in *Proceedings*, Am.Soc.C.E., Vol. 65, p. 147, January, 1939) in the discussion of a paper, "Wind Forces on a Tall Building", after stating the wind velocities given, writes, "It is assumed in the foregoing that true and not indicated velocities are dealt with." He truly says, "Lack of this distinction is a source of continual annoyance and error in many published data." The reason is that the velocity of the approaching wind as indicated by the anemometer is not the velocity of the wind striking the surface of the building. The word 'true' or 'indicated' before 'velocity' would remove any doubt as to which is meant.

ROBINS FLEMING
Structural Engineer (retired)
New York, N. Y.

Antiseismic, Not Aseismatic

Sir: In connection with Mr. Dewell's proposal (*ENR*, Jan. 18, 1940, page 71), regarding the use of a proper word to designate earthquake-resistant structures, permit me to make the following comments.

From an etymological point of

view, both *aseismic* and *aseismatic* mean in Greek one and the same thing. They are composed of the prefix *a*, equivalent to *non, without, lacking*, etc., and the adjective *seismos*, the Greek name for earthquake. Furthermore, the structure of the phonetically ugly word aseismatic is decidedly foreign to the spirit of the Greek language.

Inasmuch as this word is not found in all large standard dictionaries of the English language, its linguistic correctness can rightly be doubted. It is suggested, therefore, to use the word *antiseismic* to designate earthquake-resistant structures, the prefix anti meaning *against*. This word is current in modern Greek and the writer sees no reason why it could not be used equally well by English-speaking engineers preferring a Greek nomenclature.

A. FLORIS
Los Angeles, Calif.

War Damage to Bridges

Sir: In the editorial "Bridges and Bombs" (*ENR*, Dec. 21, 1939, p. 815), you revive a question which might, as applied to the now definitely rejected bridge from the Battery, Manhattan, to Brooklyn, be considered academic, but may still be of importance in connection with the determination of types of structure for other projected crossings. Your conclusion that the risk of bombing is not a valid reason for opposition to constructing a bridge at such a location seems to be contradicted by the following facts.

Since your editorial was published, the daily newspapers have reported that the decision by the Mixed Claims Commission on June 15, 1939, in favor of the claimants in the Black Tom and Kingsland sabotage cases has been upheld by Umpire Owen J. Roberts, Associate Justice of the Supreme Court, and the losses plus interest set at $50,000,000. These cases of sabotage occurred during the World War while the United States was still neutral. Bombing from the air and marksmanship were not involved. The work of sabotage was carefully planned and executed by agents of a foreign country who apparently mingled freely with loyal citizens to carry out their work effectively and at the time without detection. Recent stories in the daily newspapers state that a one-time secret agent and naval officer of that country, who claims to have had under his direction a corps of 3,000 saboteurs, openly takes credit for planning and laying plans for the execution of the Black Tom explosion as well as for the manufacturing of incendiary bombs, starting fires in 32 ships and fomenting waterfront strikes and disturbances.

No doubt there are potential saboteurs in this country today and among their number some who are familiar with the vulnerable points and features of a suspension bridge through which it could be wrecked by operations from land and water as well as air.

Must a bridge be actually bombed or blown up to prove that it is possible to do so or to demonstrate the degree to which its wreckage might obstruct an important waterway, or the ease or difficulty of removing the wreckage? I believe that the Secretary of War based his decision in regard to the possible destruction of the then proposed Brooklyn-Battery Bridge upon a careful study of all the aspects of the question, and certainly with the advice of engineering, military and naval experts. Upon him rests the full responsibility for maintaining access to the Brooklyn Navy Yard and also of keeping the East River open to shipping at all times, while the wrecking of the tunnel, if possible, could not affect these conditions.

A crossing from the Battery to Brooklyn is vitally necessary, and the fact that a tunnel at this location is practical from both engineering and financial standpoints makes the decision of the Secretary of War in regard to the proposed bridge all the more logical and conclusive.

LT. COMDR. F. A. ROSSELL
CEC, USNR
New York City

A Master (piece) Specification or Pity the Poor Contractor

At the recent annual convention of the Associated General Contractors in Memphis, Commissioner W. E. Reynolds of the Public Buildings Administration read, to what obviously was an appreciative audience, a specification that summarizes many a contractor's belief. This gem of overstatement, for which the Commissioner disclaims authorship, is published here for whatever good it may do.

Interpretation—The plans and specifications are to be taken together. Anything shown on the plans and not mentioned in the specifications, and anything mentioned in the specifications and not shown on the plans is to be considered as both shown and specified, and anything wanted by the owner or any of his friends, or by anybody else (except the contractor) shall be considered as shown, specified, implied and required, and shall be provided by the contractor without expense to anybody but himself. If the work has been done without expense to the contractor, the work shall be taken down and done over again until the expense is satisfactory to the owner. Coincidence between the plans and executed work shall not be considered a claim for extra compensation. The architect is not required to recognize coincidence.

Anything that is right on the plans is to be considered right, anything that is wrong on the plans shall be discovered by the contractor and shall be made right without telling the architect or indicating it in the bills. Anything that is forgotten or left out of the plans and specifications, but which is necessary and required for the comfort and convenience of the owner, whether he thought of it before or after the execution of the contract, shall be provided by the contractor to the satisfaction of everybody.

Rules and Regulations—The work throughout shall comply with all rules, regulations, caprices and whims of all City, County, State, National and International Departments, Bureaus, and officials, having or not having proper jurisdiction.

Materials—All materials shall be of the best of their several kinds, and the contractor is expected to know and provide the best, irrespective of what is specified in detail.

Further, the architect reserves the right to change his mind about what is the best. Any changes necessary to make the work and material fit, to the mind of the architect, shall be made by the contractor without extra cost.

Arbiter—In case of any dispute arising as to the nature or character of the work, specified or implied, the matter shall be decided by referendum and recall—after which the decision may be reversed by the architect.

Payments—Payments, if any, shall be made only on the architect's certificate. Architect's certificates shall not be considered negotiable nor are they legal tender. When once issued, the architect assumes no responsibility for their usefulness.

Partial payments shall be made as the work progresses in the amount of eighty-five per cent of the value of the work done, as judged by the architect. In no case shall the judgment of the architect cover more than enough to cover the payroll every Saturday night. The material men must take the customary chances. The final payment (if any) shall be made only when everybody is satisfied (but the contractor). Any evidence of satisfaction on the part of the contractor shall be considered a just cause for withholding the final payment.

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FEBRUARY 29, 1940

ELIMINATION of interior columns is an accepted objective in almost all industrial building design. That it may have equal merit in commercial structures is suggested by two ten-story buildings in New York City, owned by S. H. Kress & Co. and Tiffany & Co., in which trusses spanning from wall to wall make columns in the first or salesroom floor unnecessary. In the case of the Tiffany building, just completed, the use of trusses entailed an extra cost of some $25,000. The floor space that would be occupied by columns is, of course, not worth that much, so that the reason for the investment lies in the openness that results. This asset usually receives too little attention. If obtainable at a reasonable increase in the cost of the frame, it should pay dividends in commercial buildings as it has in industrial structures.

Grade-Marked Engineers

NOTABLE at the annual meeting of the Engineering Institute of Canada was the unchallenged decision to send to ballot a constitutional amendment abolishing the grade of associate member. Abolition of that grade is being promoted in Canada as a desirable step toward attaining close integration of the Institute with the provincial professional associations, membership in which confers a recognized legal status on the holder similar to that conferred by licensing in this country. Since the provincial associations have but one membership grade the fact that their members must enter the Institute in the subsidiary grade of associate creates a stumbling block to the movement for closer relations between the engineering and professional organizations. What the Canadian engineers have done would also seem to indicate that the Canadian engineers, whose traditions are notably conservative, have come to realize that grade distinctions in engineering societies are of questionable importance. Since state licensing in this country also marks the point at which a man is accepted legally as an engineer, artificial grading by our national engineering societies may be open to the same scrutiny that the Canadians are giving it. Perhaps grade-marking of engineers will be found to be an outmoded practice.

Knowing Electric Power

CONSTRUCTION PROGRESS through the years is due in large measure to ability to put into use new sources of power. It is vital to remember this in studying the practical article in this issue on applying electric power to ordinary construction. Those of us who witnessed the transition period will remember the trial and objurgation that accompanied the entry of the gas engine into the field of steam power. So also diesel power had its period of struggle to be known. And the contractor must likewise learn to know electric power. It will no more supplant the other sources of power now used than any of these has supplanted the others. But as each of these other power sources had characteristics that lent advantages to the constructor so has electric power. It is another tool that science and invention have fitted to the hand of the builder and he should put his hand to it and learn to apply its powers to the construction tasks for which it offers distinctive advantage. Studied in this light the article in this issue has a constructive value that warrants the closest attention.

A True Partnership

A LEADING CLAIM of day-labor construction is that it guarantees coordination of design practice, construction procedure and the selection of equipment and materials. If this practice ever was a monopoly of day labor it is so no longer. Contract construction is rapidly developing equivalent coordination. An outstanding example is the ingenious foundation operations being carried out on the Potomac River Bridge described in this issue. Here a notable pile design called for an unprecedented size of hammer, and designer and equipment engineer cooperated. Again in the sinking of an unusual form of caisson the contractor took over the designer's tentative plans and with his skill in marine work perfected them to mutual satisfaction. Then contractor and equipment engineer produced the piledriving rig to handle the long piles and giant hammer. Coordination was as complete as the vaunted single administration of day labor ever provided. It was a three-party collaboration that is now being repeated on many jobs of heavy engineering construction.

Prelude to Action

EVIDENCE continues to accumulate that the city traffic problem is entering a new stage. As one large city after another issues reports by its own engineers or by hired experts analyzing conditions and suggesting solutions, it is apparent that a brand of realism is developing in place of the pussyfooting that has characterized the conclusions of traffic study reports heretofore.

In the first place these new reports approach the traffic problem in the same way that engineers have long approached the problem of a new water supply or a new sewerage system, on a city-wide or even regional scale; no major water-supply development for one section of a city would be undertaken unless it was a part of a comprehensive and integrated plan, yet single major trafficways have often been recommended and built when no plan for their integration into a comprehensive system existed. The new approach is to lay down a complete traffic system before a dollar is spent or a shovel of dirt turned on any single artery.

The second important characteristic of these new reports is that they do not minimize the cost of an adequate city superhighway system. If the figures are astronomical they are none the less real, and the traffic planners state them without apology. And finally they are beginning to suggest ways of meeting the costs, a subject which too many earlier reports have omitted as too hot to handle.

Los Angeles is the latest city from which such a report has come. After laying down a $250,000,000 system it recommends a single six-mile route for immediate construction. Since the $20,000,000 for this parkway is not available from ordinary sources, the report recommends revenue bonds and tolls. To a good many highway authorities this will seem to be surrender to a principle that was discarded many years ago as bad. To the extent that motorists already are taxed for many miles of road that are not built because of diversion of highway funds to other purposes a good case can be made against the additional charge that a toll road entails. Realism, however, suggests that even if these diverted funds were available they could very easily be spread—and probably under political pressure would be spread—over a vast mileage of rural roads without aiding in the least a solution of the city traffic problem. The Los Angeles planners therefore accept the toll principle as the only one which will permit substituting actual construction for talk on city traffic.

Chicago, Pittsburgh, Detroit and Boston in addition to Los Angeles have traffic plans before them. The fact that some of these new traffic reports attempt to come to grips with the practical aspects of the problem of city traffic indicates that they may represent a prelude to action.

Good Work

SHORTLY after the World War the Associated General Contractors of America was organized to serve the interests of contracting in a war-disrupted nation. Reaching its 21st birthday at its recent Memphis convention, the A.G.C. celebrated its majority by taking action on several matters that place the organization higher in leadership of the general contractor element of the construction industry than ever before.

One of the outstanding steps taken at Memphis was the endorsement of federal investigation of the industry. Acknowledging that certain conditions existing in construction are against the public interest, the A.G.C. expressed willingness to cooperate in cleaning up the great industry of which it is a vital part. Such acknowledgment, incidentally, is still lacking on the part of organized labor.

Today, the contractors are faced with a curtailment of public works, aggravated by WPA invasion of what is left of that field and a hesitating private market. In spite of the obvious personal advantage of continued heavy appropriations for public works, the contractors tempered their wishes for further public works expenditures with a desire to see the budget balanced.

Another example of progress was the presence on the program of John P. Coyne, A. F. of L. building trades president, signifying a sincere desire on the part of both labor and contractors to understand each other's problems and to cooperate intelligently in working together in an industry from which both make their living. Already much has been accomplished toward eliminating jurisdictional disputes, and it is not impossible that contractors by insisting upon dealing only with responsible unions and labor leadership can aid labor in stamping out its racketeering element. Determination to separate highway-heavy and building fields in labor negotiations is another example of sound A.G.C. labor procedure.

Heartening, too, is the progressive attitude toward other problems such as apprentice training, uniform prequalification, contracting procedure, housing, and highways. On its record the A.G.C. has not only justified its existence but set a high standard for trade associations in general.

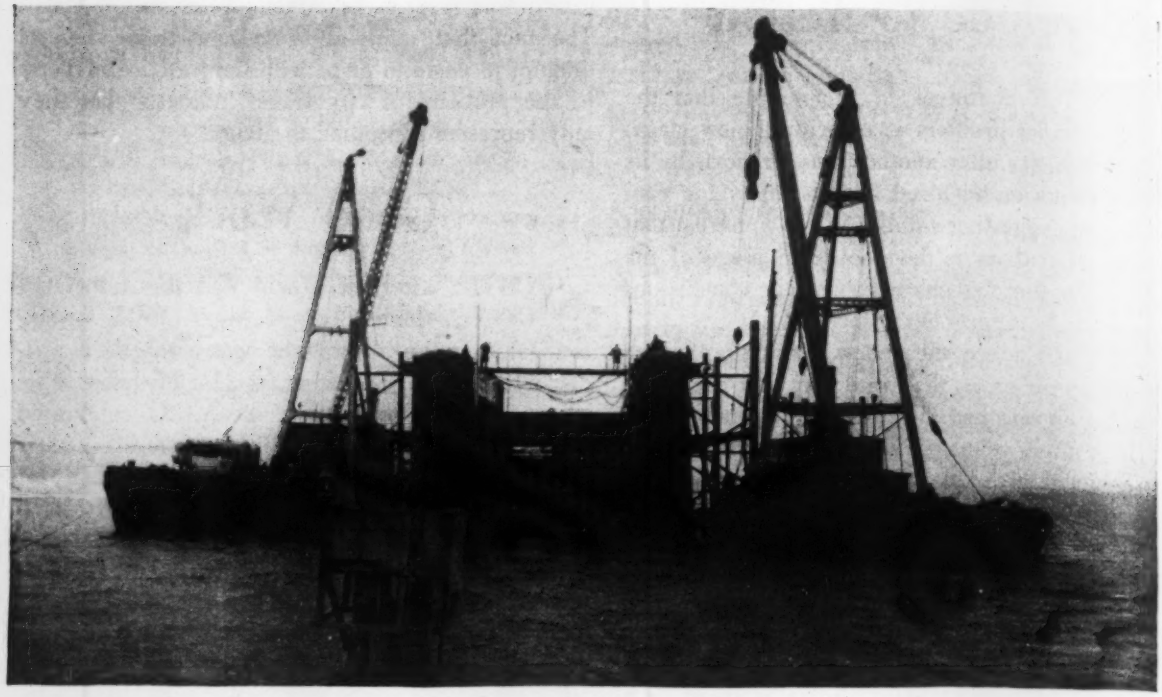

FIG. I. SINKING A FOUR-CYLINDER CAISSON FOR POTOMAC RIVER BRIDGE.

Long Piles and Floating Caissons For Potomac River Bridge Piers

***Contents in Brief**—The longest steel H-piles ever used for bridge piers, 194 ft. long, are being driven by a special 16-ton steam hammer, the largest ever built, for the foundations of the new Potomac River Bridge at Ludlow Ferry, Md. Piles for the river piers are driven through timber platforms anchored on the river bottom. The main piers are two-shaft and four-shaft steel caissons, the latter floated to place, sunk to a prepared pile foundation by releasing entrapped air, and then filled with concrete. About one-third of the two-mile length of structure is a trestle bent approach on long steel piles. The main superstructure is made up of Wichert trusses with an 800-ft. center span.*

FOUNDATIONS for the new two-mile bridge being built by the Maryland State Roads Commission over the Potomac River at Ludlow Ferry, Md., 50 miles below Washington, are most unusual in both design and construction. More than 37 miles of steel H-piles, up to 194 ft. long and, as far as known, the longest of this type ever used, are being driven for both the long trestle approach on the Virginia side and the river piers. The piles, weighing up to 12 tons, are driven with their tops as deep as 80 ft. under water by a special 16-ton steam hammer equipped with a 7-ton ram, mounted on a floating piledriver having 90-ft. telescoping leads. For the river piers the piles are driven through holes in timber platforms anchored at river bed by timber piles. Over the pile clusters sticking above the platforms are placed bell-bottom steel cylindrical caissons in assemblies of two or four cylinders connected by double steel diaphragms. Caisson shells remain as steel protection for the encased concrete.

Merritt-Chapman & Scott Corp., the substructure contractor, is utilizing its long experience in the salvaging of ships with compressed air to place the four-shaft caissons, which are assembled at the railroad dock two miles from bridge site, floated by blowing out the lower chambers, towed to place and sunk by releasing the air (*ENR*, Nov. 20, 1939, p. 4). The special 16-ton hammer, built by McKiernan-Terry Corp., and the big piledriver built for the job, were also described briefly in *ENR*, July 13, 1939, p. 5.

General project

The bridge, the only one across the Potomac below Washington, was designed by J. E. Greiner Co., consulting engineers at Baltimore. It will provide a by-pass for U. S. Route 1 around the city of Washington. The project is being financed by State Roads Commission bonds and a PWA grant.

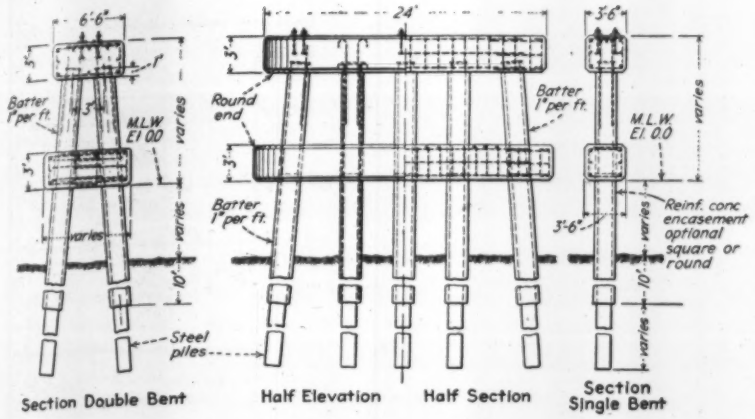

Fig. 2. **Details of five-post trestle bents, some of which required H-beam piles 194 ft. long.**

From abutment to abutment the bridge is 10,050 ft. long. It will carry a 24-ft. concrete-filled steel-grid roadway and two 18-in. emergency footwalks. Beginning at the west abutment in Virginia, the bridge consists of 60 I-beam spans of 61½ ft. each on trestle bents; six continuous Wichert deck girder spans from 118 to 162 ft. long; six continuous deck truss spans of Wichert design from 276 to 350 ft. long, in two units; three main channel cantilever truss spans, consisting of two anchor arms of 366 ft. 8 in., and two cantilever arms of 200 ft. and a suspended span of 400 ft., making up the 800-ft. clear opening over the channel; then four Wichert truss spans similar to those on the other end of the channel section, connected to the east abutment by six Wichert girder spans. The channel span rises as a through truss to provide a navigation clearance of 145 ft.

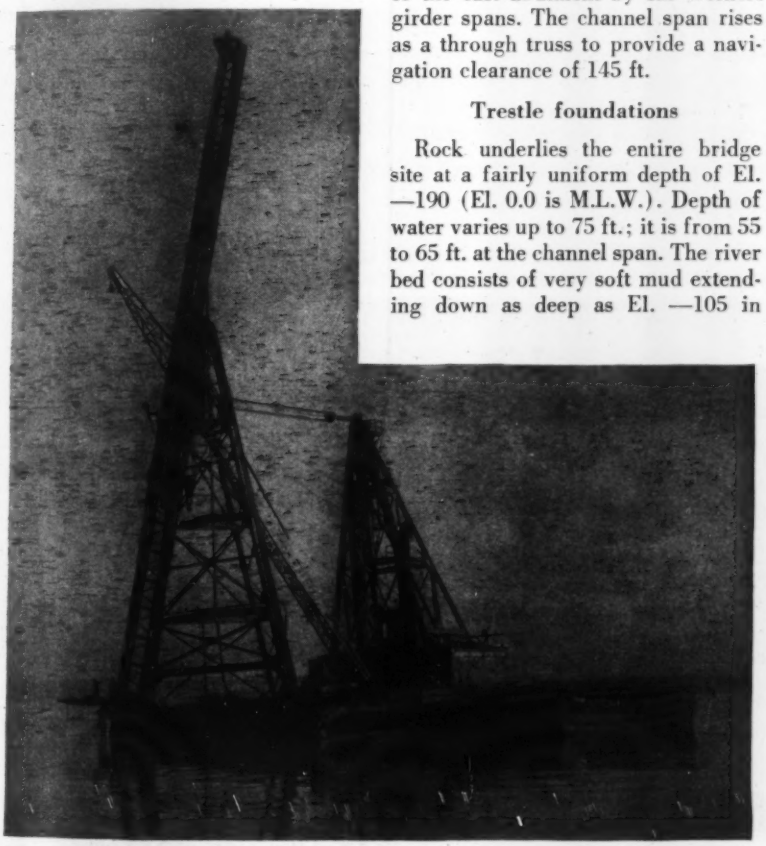

Fig. 3. **World's largest floating piledriver, built to drive 194-ft. steel piles. The telescoping leads permit driving the top of piles 85 ft. below water.**

Trestle foundations

Rock underlies the entire bridge site at a fairly uniform depth of El. —190 (El. 0.0 is M.L.W.). Depth of water varies up to 75 ft.; it is from 55 to 65 ft. at the channel span. The river bed consists of very soft mud extending down as deep as El. —105 in places; underlying the mud are various formations of sand, gravel and clay.

The 59 trestle bents on the Virginia approach are made up of five steel H-piles, the two outside piles are battered 1:4. Every sixth bent is a double one. Piles vary from 12 x 12-in. 53-lb. to 14 x 16-in. 102-lb. sections. Specifications call for a minimum depth of driving for each pile, varying from El. —82 to El. —171, but in any case the piles must be driven to a bearing value of 45 tons as figured by the modified *Engineering News* formula:

$$P = \frac{2W_h H}{S + 0.1\,\frac{W_p}{W_h}}$$

where P = bearing capacity in lb.
W_h = weight of hammer ram.
H = fall of hammer in feet.
W_p = weight of pile in pounds.
S = average penetration per blow for last 10 blows, in inches.

Each pile is capped with a welded grid of 1 x 2-in. bars and in each bent the piles are tied together with a concrete collar at waterline and a concrete cap. Top of caps varies from El. 11.5 at the abutment end of the approach to El. 20.6 at the river end, thus the minimum length of pile runs from 92 to 192 ft. Each pile is to be encased in concrete, square or round section, with a minimum thickness of 4 in. outside of steel, from 10 ft. below river bed to the top.

There are 340 piles in the 59 bents, aggregating 46,590 ft. long and weighing 1,824 tons.

River piers

There are three general designs of the twenty river piers. Piers 1, 2, 3 and 20 are of orthodox design, with round-end bases from 14 to 24 ft. wide and 35 to 53 ft. long, surmounted by shafts from 6 x 37 ft. to 7 x 39 ft. in plan. They vary from 27½ to 38½ ft. high. Piers 10, 14, 15 and 19 each consist of four cylindrical concrete shafts connected by 4-ft.-thick concrete diaphragms in both directions. The cylindrical bases on Piers 14 and 15, carrying the main channel span, are 32 ft. in diameter; the shafts taper to 9 ft. at the top; the other two are 24 ft. in diameter at the bottom, 7 ft. at the top. The remaining twelve piers are double cylinders, connected by a diaphragm. Bases vary

from 18 ft. to 28 ft. in diameter; tops from 6 to 10 ft. Typical designs are shown in the accompanying drawing.

The site of each pier was dredged to 13 ft. below river bed; bottom of pier is 3 ft. higher. Bottom elevations vary from —17.5 to —86. In general, top of piers is El. 10; thus pier heights run from 27.5 to 96 ft. Specifications permit pouring of all concrete below El. —10 by the tremie method, but require tight steel forms for all such concrete. The steel forms may be left in place. A steel plate protection is called for on all piers between El. —2 and El. 4. The piers are heavily reinforced.

All river piers are founded on steel H-piles driven to rock and protruding from 10 to 17 ft. into the base concrete. As the pier bases follow the river bed in general and the ledge is practically level, the longest piles are under the piers near shore. Here the piles run up to 194 ft. in length; in the deepest piers the piles shorten up to 126 ft. Under the cylindrical bases the piles are arranged in concentric circles; some are driven plumb, others on batters of 1:4 and 1:6.

Specifications permit only one splice per pile. At splice points the ends of the beams are milled square for even bearing, splices are made with plates riveted to the webs and angles riveted to the flanges. Pile points are reinforced with plates and angles. One part of the spliced piles is a 115-ft. length; the other part is as long as needed, and the piles are driven short section downward. At the top of each pile are a minimum of seven pairs of 5 x 3½ x ⅜-in. lug angles, welded between the flanges, to provide additional bond to the concrete base. The piles are designed for a load of 65 tons each; under certain conditions of tide, wind and ice, occasional piles might carry loads up to 130 tons.

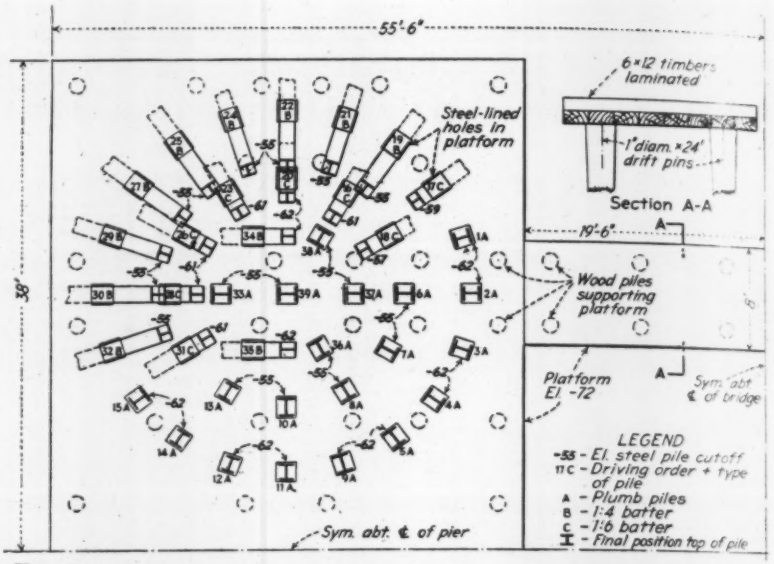
55'-6"
6 x 12 timbers laminated
Steel-lined holes in platform
1" diam. x 24' drift pins
Section A-A
19'-6"
Wood piles supporting platform
Platform El. -72
Sym. abt ℄ of bridge
LEGEND
-55 - El. steel pile cutoff
11C - Driving order + type of pile
A - Plumb piles
B - 1:4 batter
C - 1:6 batter
I - Final position top of pile
Sym. abt. ℄ of pier

Fig. 5. Design of timber platform for Pier 15, and sequence of driving foundation piles worked out for this particular pier. Because of batter and varying cutoff of piles, careful planning was necessary in working out a driving program to prevent fouling of driver leads.

Ten steel test piles were driven in the trestle bent area to determine the length of piles required. The longest of these was 215 ft.

Piledriving

In the specifications the engineers suggested use of a timber platform supported on timber piles, at river bed level as a template for driving the steel piles and as a bottom form for the pier bases. This method (patented by William G. Adams, Richmond, Va.) was adopted in general by the contractor, though modified in some details.

The first job in preparation for driving the pier piles was to dredge an area at each pier site 13 ft. below river bed, extending a minimum of 10 ft. outside of the structure lines. Next was the driving of wood piles to support the platforms, some requiring as many as 162 piles and up to 90 ft. in length. After the piles were driven they were cut off to platform grade (bottom of pier) by a special floating saw rig. This was a converted floating piledriver, with a 4-ft. circular saw mounted on an I-beam sliding in the leads. It was powered by a steam engine through bevel gears and a belt drive. The saw could be held at any depth desired up to 87 ft. below water. No attempt was made to go after individual piles, but the entire pier area was systematically swept by the saw by maneuvering the rig through anchor lines attached to power winches on the boat.

The platforms were fabricated alongside the railroad dock and floated to the bridge. They were built up of two layers of 6 x 12-in. timbers, laid flat and skin tight, and spiked together. For the four-shaft piers the

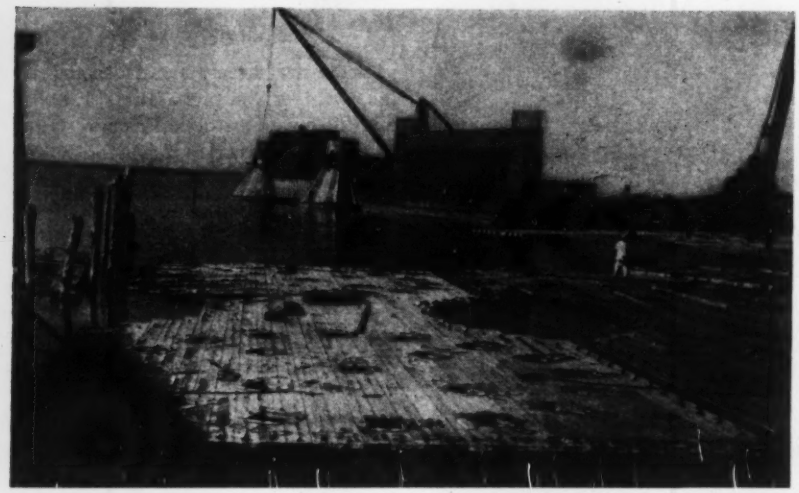

Fig. 4. One of the laminated timber platforms ready to be towed to a pier site and sunk to bearing on wood piles at river bed level. Holes cut in platforms serve as guides for foundation piles; platforms are also used as base for steel caissons.

platforms consisted of two rectangular sections serving two shafts each, connected by two timber grillage ties. For the two-shaft piers the platforms were dumb-bell shaped with square ends. As to the size of some of the platforms, that for Pier 15 is an example: Two sections 36 x 76 ft., connected by two 8 x 39-ft. ties, and requiring 71.3 M fbm timber.

Rectangular holes, spotted for exact location of piles, were cut in the platforms as a guide for each steel pile. These holes, which varied in size to allow for the different batter of piles, were cut with an air drill and lined with steel plate and angles. After being towed to the pier sites, the platforms were sunk by weighting with rails and steel piles; sinking was controlled by lines from derrick boats. When the platforms were landed, they were anchored by dowels into tops of the supporting piles, placed by a diver. As soon as a plumb pile and a couple of batter piles had been driven through a platform, it was sufficiently anchored to permit removal of the weights.

All of the steel piles for the piers and the trestle bents 49 to 59 are driven with the big special driver. This is one of Merritt-Chapman & Scott's large derrick boats, the *Chief*, converted to a driver by adding a 90-ft. all-welded steel A-frame at the front end, which carries telescopic leads that can be extended 60 ft. above top of tower and 95 ft. below deck. The leads can also be swung to any batter up to 1: 4. The hammer, largest ever built, weighs 16 tons and contains a 7-ton ram delivering a blow of 37,500 ft.-lb. Such a hammer was called for in the specifications.

The steel piles are shipped by rail to the unloading dock where they are spliced to the desired length, then are loaded on barges and towed to the driver.

Sequence of driving

Pier piles are driven in concentric circles as clusters under the cylindrical pier bases. The biggest problem in driving is to work out a sequence of driving the piles that will result in no interference with each other or with the timber piles under the platform. At platform level the piles are in a certain pattern, but because of the 1: 4 and 1: 6 batter on some piles and the different cutoff elevations, the pattern changes constantly between platform and highest cutoff.

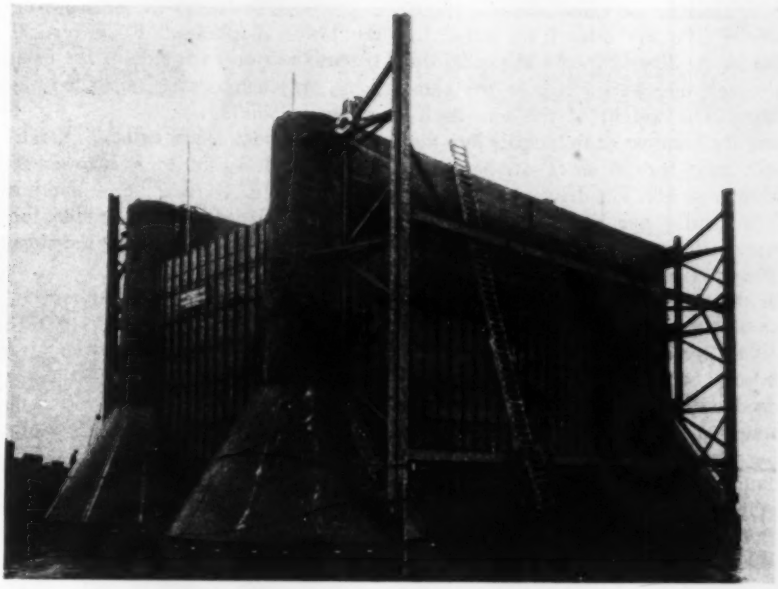

Fig. 6. Four-shaft steel caisson ready to be towed to Pier 14. The larger caissons were sunk by releasing air from the four cylinders; sinking is guided and controlled by two derrick boats as shown in Fig. 1.

Pile lengths are determined by cutoff level and the elevation of rock as revealed by borings. Any pile protruding above its designated cutoff level must be cut off under water; likewise, any pile driven below designated cutoff must be spliced under water with a special structural cap. The piles extend well into the sloping bell of the pier cylinders, and as there is little theoretical clearance in many cases between pile and cylinder, very careful driving is required.

The big driver is stable enough to permit very accurate driving under normal water conditions, but driving is not so easy in rough water. When a pile is partly driven it is in a precarious position, for a slight roll of the driver, even that caused by wash of a passing small boat, might snap the pile.

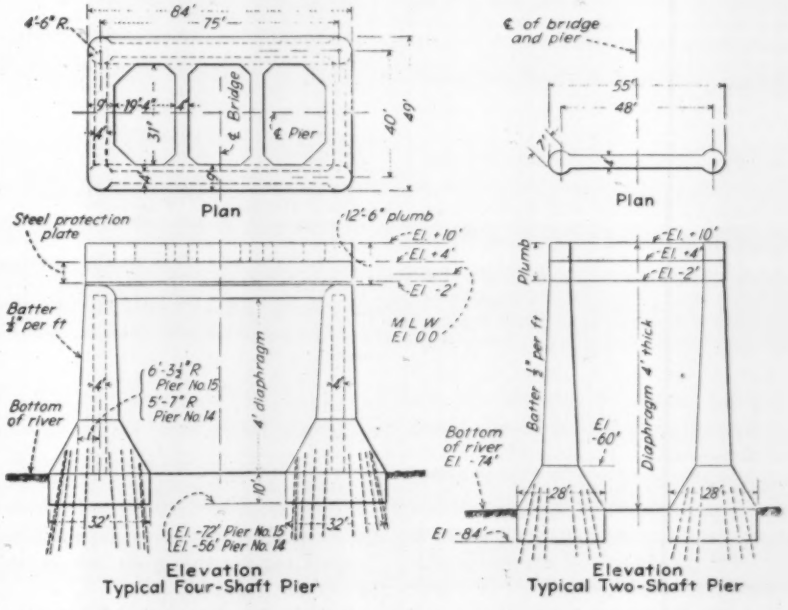

Fig. 7. Piers 14 and 15, carrying the main channel span, are of unusual design. Four flaring steel cylinders, connected by double steel diaphragm walls, were fabricated as caissons for these and two other piers. Most of the remaining river piers are two-cylinder caissons.

A 135-ft. derrick boom on the driver lifts the piles from barge to leads. A diver threads the pile tip through the proper hole in the platform. The weight of the pile itself, and the hammer drop the pile into the soft mud for 50 or 60 ft. before a blow is struck. The driver works three 7-hr. shifts per day, seven days a week. Progress now averages four piles per shift, though one pile per hr. has been driven under favorable conditions.

In preparation for driving the trestle bents, a 9-ft. channel was dredged by the contractor from deep water to the west abutment for floating plant. A standard floating driver, equipped with swinging leads and another special McKiernan-Terry hammer started at Bent No. 1, next to the abutment, and is backed out of the channel, driving each bent in turn up to Bent 45. From there on, the piles will be driven by the big driver.

Sinking pier shells

All of the shells are being assembled at the railroad dock. Shells for the four-shaft piers, 10, 14, 15 and 19, were fabricated on a submerged platform alongside the dock. The shells, of ¼-in. steel plate, were designed to completely encase the piers from bottom of base to El. 4, or 6 ft. below top of concrete. Maximum height of four-shaft shells is 76 ft. The plans call for a continuity of reinforcing from the 4-ft. diaphragm walls through the corner cylinders. As the contractor desired to use the cylinders as air chambers for sinking purposes, it was necessary to build them as complete cylinders without an opening between cylinders and wall. To get the continuity of reinforcing, the contractor inserted flat bars, of equivalent cross-section to the reinforcing, through the cylinder shell, welded tight. The reinforcing bars are welded to these straps. Short sections of split I-beams were welded to both sides of the shell to carry the shear between wall and cylinder. All reinforcing is placed within the shells at the dock.

Sunk by air

Each of the four cylinders is divided into two air chambers by diaphragms installed at the midpoint and top. The lower chamber is open at the bottom. Air pumped into this chamber floats the caisson; compressed air at 15 lb. pressure in the upper chamber eases the pressure on the lower diaphragm. Four vertical trusses, two on each side of the caisson, are temporarily installed as guides in sinking.

When afloat, each caisson, weighing as much as 450 tons, is towed to the pier site. Here a large floating derrick is placed along each side, the truss guides bearing against the sides

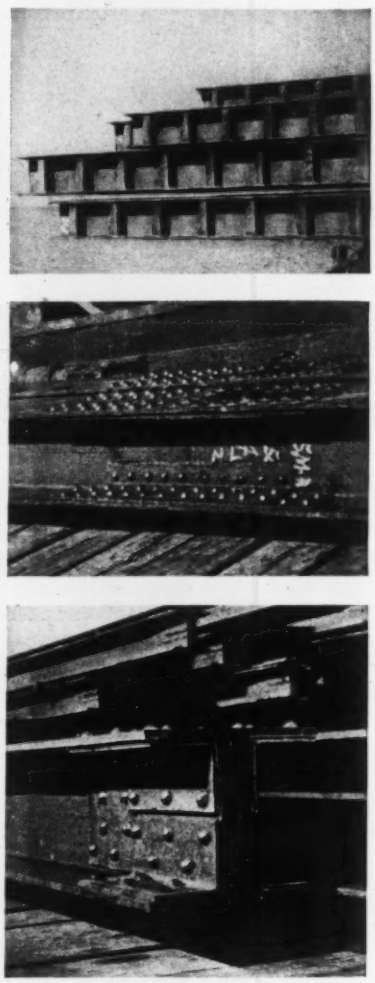

Fig. 8. Steel pile details. Top: angle lugs at top of piles for additional concrete bond; center: splice in a long pile; bottom: reinforced point for heavy driving.

of the barges. Lines from the hoisting equipment on the derricks are rigged to the bottom of trusses. The caissons are sunk by releasing air from the lower chambers. A strain is held on the hoist lines to control the sinking. Targets for the surveyors are set on top of the caisson.

Two of the four-cylinder caissons have been sunk by these methods; the other two are now being fabricated. Sinking is accomplished in about three hours. Divers at platform level make sure the cylinders came down outside all piles, and the alignment is checked by surveyors. The caissons land on the platforms, which later serve as bottom forms for the concrete fill.

All of the two-cylinder caissons are being sunk by derrick boats. Those for Piers 13, 17 and 18 are fabricated in two pieces (horizontal joint); Pier 16 is in three sections. All others are fabricated complete on a barge, then hoisted and set into place by a floating derrick. The heaviest of these single-unit caissons weighs 82 tons. The sectional caissons are fitted with flanged joints, and the sections are bolted together by a diver.

Concrete placing

All concrete for the foundations is placed from a floating plant containing two gas-engine-driven 1-yd. mixers, fed by weighing batchers. From the mixers, the concrete is hoisted up a tower by bucket, discharging into a chute for final delivery.

In the piers all concrete is poured by tremie up to El. —10; then the caissons are pumped out and the remaining concrete, to El. 10, is placed in the dry. The forms above El. 4 must be removed; the steel shells below remain in place.

Besides the floating concrete plant and the piledriver *Chief*, the contractor has the following floating plant in use on the job: five derrick boats of 100, 35, 25, 15 and 10 tons capacity; a combined piledriver and saw rig; a floating revolving crane; 2 tugs and a score of barges. The working crew consists of 177 laborers and mechanics, including seven divers.

Direction

J. E. Greiner Co., consulting engineers of Baltimore, designed the project for the Maryland State Roads Commission, and is supervising construction. Raymond A. Archibald is resident engineer for the consultants. G. H. Sykes represents PWA on the job. For Merritt-Chapman & Scott Corp., New York, substructure contractor, Frank W. Barnes is construction manager and Wm. Denny is superintendent. Carnegie-Illinois Steel Co. is furnishing all reinforcing and piles and is fabricating the steel caissons.

The Harris Structural Steel Co., New York, has the contract for the superstructure.

Viaduct Approach to Lincoln Tunnel

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Contents in Brief—Need for building a six-lane viaduct on soft New Jersey meadows challenged the designing ingenuity of the Port of New York Authority's staff. Pile foundations were used over much of this job, and the bent and span layout provides a maximum of preparedness for uneven settling of the individual piers. The project was designed with an eye to beauty as well as to engineering suitability.

THE STEEL VIADUCT near the western end of the New Jersey approach to the Lincoln Tunnel at New York City is an unusual structure and a rather striking departure from the types of viaduct that have been used in the past. It was designed to meet the special conditions that prevailed at the site and, at the same time, to give the most pleasing esthetic effect possible.

Fig. 1 shows a general plan of the structure. The straight portion, 1,152 ft. long, consists of two 32-ft. roadways with a 5-ft. separation and two 3-ft. sidewalks. A 2-lane ramp adjoins the east end of the main structure; another one, circular in plan, connects near the center of the straight portion.

Most of the main viaduct is from 35 to 55 ft. above the New Jersey meadows, the clay of which is unsuitable for heavy foundations unless they are supported on piles or on caissons that go down to rock. Such a condition made it advisable to use a type of construction which would be as light as practicable, with rather long spans, so as to minimize the cost of the foundations.

In order to meet this situation, the following general specifications were set up for the design of the structure: (1) at the easterly end, where the rock is less than 50 ft. below the surface of the ground, the foundations shall go to rock; (2) other foundations shall be supported upon timber or concrete piles, and each foundation shall be continuous so as to avoid unequal settlements; (3) the west abutment, the piers near it, and the superstructure itself shall be designed so that adjustments can be made for vertical and horizontal displacements due to the effect of the 35-ft. embankment to which the viaduct connects; (4) the roadway and sidewalks shall consist of reinforced-concrete slabs; (5) steel shall be used for the superstructure, including its vertical supporting members; and (6) the type of construction for the superstructure shall be attractive and consistent throughout, it shall utilize the benefits of continuity and restraint, and it must not be endangered by possible movements of foundations.

The layout which was adopted for the main portion of this viaduct is shown in Fig. 2. The locations of pinned and expansion joints should be examined carefully.

A brief review of the layout shows that settlement of the west abutment will merely tilt the short span; motion of Pier No. 1 will tilt the two-hinged bent or lower the second unit; the fixed leg at Pier No. 2 prevents horizontal movement of the whole westerly portion up to the first suspended span; settlement of Piers No. 2 or 3 will cause only rotation of the span above them; any differential vertical settlement of Piers No. 4 and 5, or 6 and 7, will rotate the rigid frames as a whole and will tilt the suspended spans but the frame action of the structure will hold each unit against horizontal forces. The easterly unit, being founded upon rock, is not subject to settlement. The legs at Piers No. 2 and 3 are relatively short and rigid. If span 2–3 had been made a rigid frame, these short bents would have been subjected to the influence of undesirably large stresses.

The circular ramp, as shown in the background of Fig. 3 and in Fig. 6, appears to be similar to the straight viaduct, but it is considerably different. The bents are composed of double legs. The first span has hinged supports at its junction with the main structure but it has a fixed leg at the other end. The next three units are single-span rigid frames that are set as chords of the curve, the legs of each unit being hinged at the bottom and completely separated from the adjacent spans by vertical cuts along their centerlines. For the remaining four spans, the legs become relatively

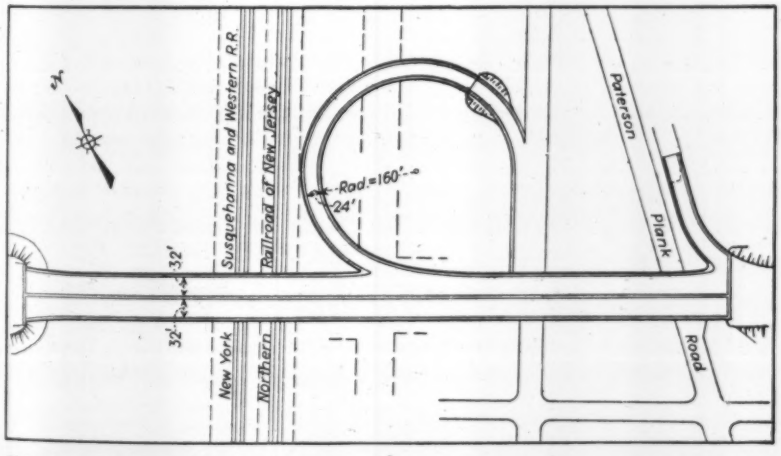


Fig. 1. **Plan of viaduct approach to depressed way across New Jersey's Palisades to the Lincoln Tunnel under the Hudson River to midtown Manhattan, New York.**

short so that it is advisable to abandon the use of rigid frames. Therefore, the remaining units have the legs at the downhill end hinged at the bottom but fixed at the top so as to hold the spans in position; the other legs are hinged at both top and bottom, being really elongated rockers.

The short ramp connecting to Paterson Plank Road is primarily a series of simply supported spans on columns that are founded upon rock.

The foundations, as shown in the foreground in Fig. 3, appear to be small concrete pedestals. Those at Piers No. 7 and 8 extend down to the rock, but the others are supported on continuous reinforced-concrete footings on top of piles. The piers of the main viaduct are about 84 ft. long and 22 ft. wide. These extend under all four pedestals and they are carried on 144 piles, mostly timber, about 60 ft. long. The piers of the circular ramp are similar but smaller, with only two pedestals.

As shown in Fig. 3 the superstructure of the main viaduct consists of two parts, one for each roadway. There is a complete separation of the two roadways except for small flexible struts near the tops of the portals. This isolation of the two portions is essential in such a long-span flexible structure because of the effects of unequal live loads. The struts serve to transmit the thrusts due to wind so that both bents will participate equally in resisting such loads.

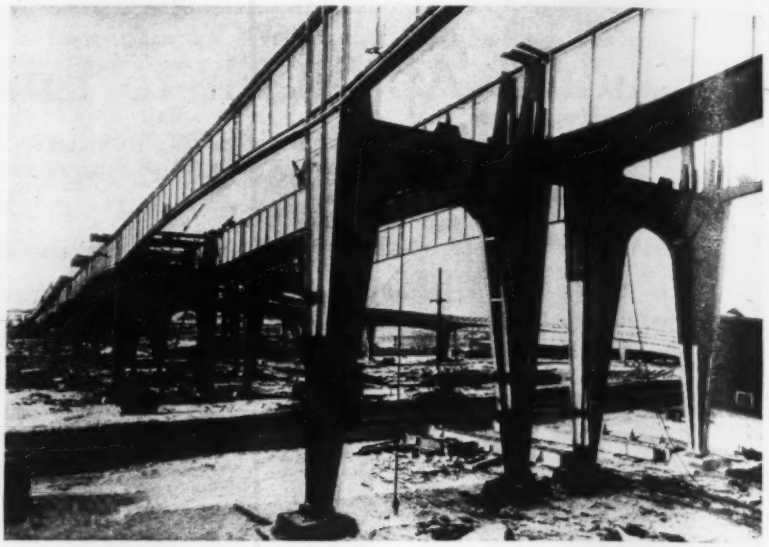


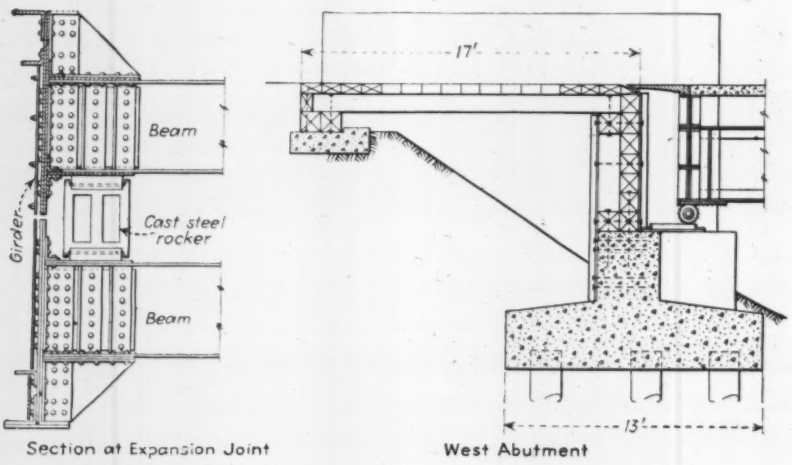
Fig. 3. Construction view of the viaduct, looking northwest. Curved ramp can be seen in the background.

The main supports for each roadway consist of two deck girders with curved bottom flanges. These are carried on tapered plate-girder legs as pictured in Figs. 3 and 4.

The flanges of the main girders are emphasized by the use of a secondary angle on the outside of the web of the exterior girders, giving the flanges the effect of wide, deep chords.

All of the main girders and the bents are carbon steel because the greater deformations and vibrations which would accompany high unit stresses are undesirable. Furthermore, although spans 4–5 and 6–7 are designed as rigid frames, the main girders are proportioned so that they can withstand the increase of positive bending moments at their centers in case any lateral yielding of the foundations should occur in the future.

The vertical legs are about 8 ft. wide at the top and 2 ft. at the bottom as shown in Fig. 3. Their flanges and



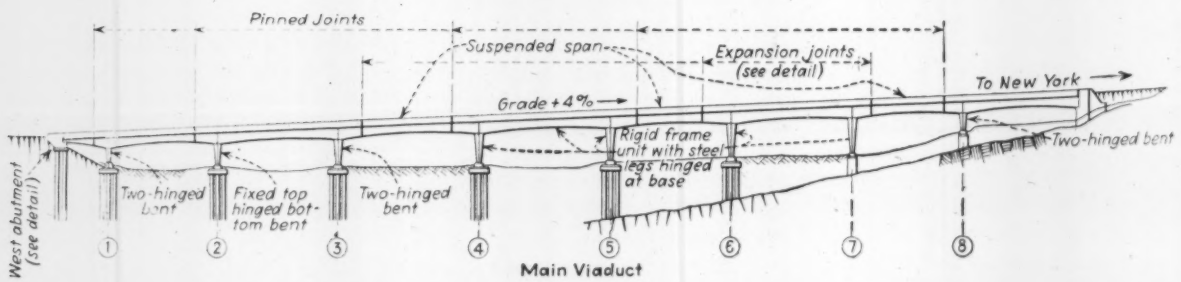


Fig. 2. (Below) Drawing showing span and bent arrangement for the straight section of the viaduct approach to Lincoln Tunnel. (Above, left) Load transfer at expansion joint is accomplished by use of a heavy cast steel rocker. (Above, right) Considerable provision for adjustment, both vertical and horizontal, is made at the west abutment.

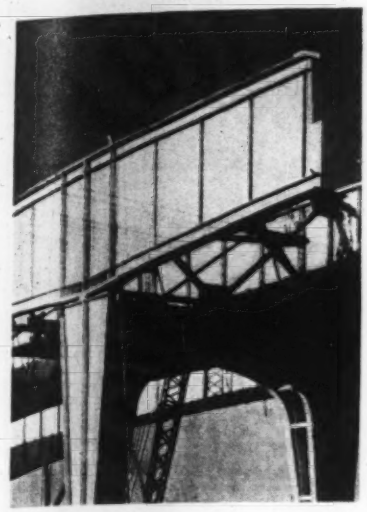


Fig. 4. Detail showing hinged support at the top of the leg at pier No. 3.

the vertical angles at their centers give them pleasing, tapered lines. No stiffeners are used on the outside of the legs but the tapered, double-webbed portal bracing and its diaphragms stiffen the legs adequately. These portals are double in order to provide torsional resistance to prevent buckling of the legs as well as of the braces themselves. The bearings of the legs of the main structure are merely curved-faced slabs with an interlocking arrangement to withstand longitudinal and transverse shears.

The junction of the main girders and the legs presented a difficult problem. In the case of the joint shown in the foreground in Fig. 3, the connection is fixed. It must withstand a large bending moment, but the flanges of the girders must be continuous, inasmuch as this is a point of maximum negative bending moment in the girders. The picture shows the solution: the flanges of the girders rest on the milled tops of the legs and are riveted to their top angles, but the main connection is provided between the webs of the portal bracing and large gussets that are riveted to the insides of the girders.

On the other hand, the hinged support at the top of the leg at Pier No. 3 is shown in the left side of Fig. 4. The legs are cut short, the curved flange angles are brought to the center of the leg before their curvature is reversed, a hinged bearing of billet steel is inserted between the girders and the legs, overlapping angles are inserted to appear to close up the open space beyond the bearings, and short welded stiffeners are added at the bottoms of the girders to help support the outstanding legs of the flange angles. The double portal webs are attached to a single cross-frame by means of flexible plates which will transmit shear but not bending moments.

The floorbeams are 24-in. silicon steel, about 6 ft. apart, except at the expansion joints, where riveted plate girders are used. There is a continuous longitudinal beam along the centerline between girders, which is spliced at each floorbeam, except at expansion joints and stress-relieving joints where motion is permitted. These beams serve as longitudinal distributors to spread the effect of concentrated live loads and to prevent cracking of the slab due to different deflections of adjacent floorbeams. The slab itself is 9 in. thick, reinforced with welded trusses, welded to the top flanges of the floorbeams.

Another unusual detail is the support for the hinged and expansion ends of the suspended spans. It was essential to devise a bearing which would not wear or resist longitudinal motion, which would permit angular rotation vertically and horizontally, and which would not be visible from the outside. Fig. 2 (upper left) shows the design worked out. The floorbeam at the end of the cantilever carries a cast steel rocker which in turn supports another floorbeam at the end of the suspended span, all of this construction being between each pair of girders. The slot between the ends of the girders is shielded from view by plates that are bolted on the outsides of the webs. The details of the lateral bracing are arranged so as to deliver the reactions at the centerline between the girders, one end permitting longitudinal motion and the other end being held by a pinned joint.

The main expansion joints in the roadway consist of toothed castings. The joints in the roadway above the pinned ends are composed of two 10-in. bulb angles with a clear space of about one inch between them. In addition to these, stress joints near the points of contraflexure prevent the roadway slab from being overstressed by participation in the continuous action of the supporting system.

The design of the west abutment caused many headaches. It was inevitable that a newly-placed, extensive fill 35 ft. above the level of the meadows would settle vertically, and its extremity would move horizontally. (Thus far it has fulfilled expectations in both respects.) The abutment is shown in Fig. 2. It is essentially a light, continuous, reinforced-concrete mat that is supported upon 84 16-in.-dia. concrete-filled steel-shell piles. The piles cannot stop the general settlement of the clay under the fill, or its horizontal movement due to its tendency to flow out from under the embankment —they merely eliminate the effect of local compaction of the fill itself. The backwall of the abutment is made of timber with a wooden apron 17 ft. long resting upon a small concrete pad at the top of the embankment. All of this construction is temporary and designed for alteration from time to time as conditions may require. It is hoped that settlement eventually will cease so that the timber can be replaced by permanent reinforced-concrete construction.

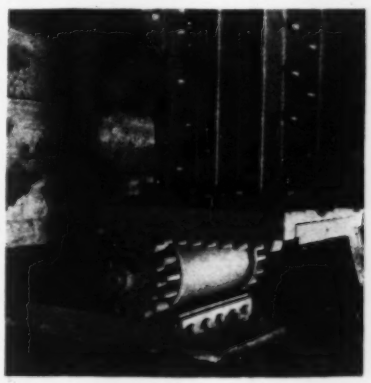


Fig. 5. As much as 2 ft. horizontal movement can take place in the west abutment, thanks to the action of four of these geared rollers.

The details of the bearings at the west abutment are shown in Fig. 5. The end span was made very short in order to minimize the reactions upon the abutment. Therefore, each bearing consists of a simple 8-in. roller with a rack and pinion arrangement to hold it in line, a long narrow slab on the bottom of the girder, and a similar one on the abutment itself. The rollers are set so as to permit the abutment to move about 2 ft. before serious difficulties will arise. The end floorbeams are designed so that the entire end of the span can be jacked up to permit the insertion of fillers

under the flanges of the girders to provide for vertical adjustment. The same horizontal motion of 2 ft. is provided for at the expansion joint in the roadway. The support of the cast steel apron is hinged and its westerly end slides upon a steel plate on top of the timber backwall.

Pier No. 1 is also subjected to horizontal and vertical motions that are caused by the embankment because it is near the toe of the slope. Therefore, the pedestals and bearing slabs are elongated, the steel bent is hinged at both ends, and the details are arranged so that the bent can be jacked up, "walked" along and shimmed as required to adjust it properly. Some movement of this pier also has occurred.

The circular ramp proved to be quite simple and satisfactory. The girders are set as chords of the curve but the roadway and the floorbeams follow the curve, as shown in Fig. 6. Fillers on top the girders permit adjustments due to the effects of curvature and superelevation. On account of the double, separate legs at the piers, the use of double-webbed, tapered portal bracing for each individual leg was not practical because of the lack of sufficient space. On the other hand, single-webbed portals seemed to be too flimsy for safety. Therefore, a single, trussed bracing system is used between each of the two sets of legs at the piers.

The bearings of this ramp are cast steel shoes with forged pins. They are designed to resist uplift as well as compression and longitudinal and transverse shears.

The details at the junctions of the girders and legs are shown in Fig. 6. At the fixed ends, the legs extend full height and the girders are spliced into them. At the pinned joints, a hinged bearing is inserted between the girders and the legs as shown in the background of Fig. 6.

The railing is very strong but simple. It is composed of vertical 8-in. beams, a built-up channel top rail, and a solid plate with longitudinal stiffeners on its outer face. This plate is riveted to the roadway side of the posts. This arrangement permits a car to skid off the railing in case of an accident but it also gives the desired panel effect from the outside, as shown in Fig. 6.

The foundations of this viaduct were built by the I. B. Miller Contracting Corp.; the steelwork of the superstructure, by the American Bridge Co.; and the deck slab and sidewalks, by the Duffy Construction Corp. The design was made and the construction was supervised by the Port of New York Authority. O. H. Ammann, director of engineering, J. C. Evans, chief engineer, Ralph Smillie, engineer of design, and C. S. Gleim, engineer of construction. Aymar Embury II was architect on the job.

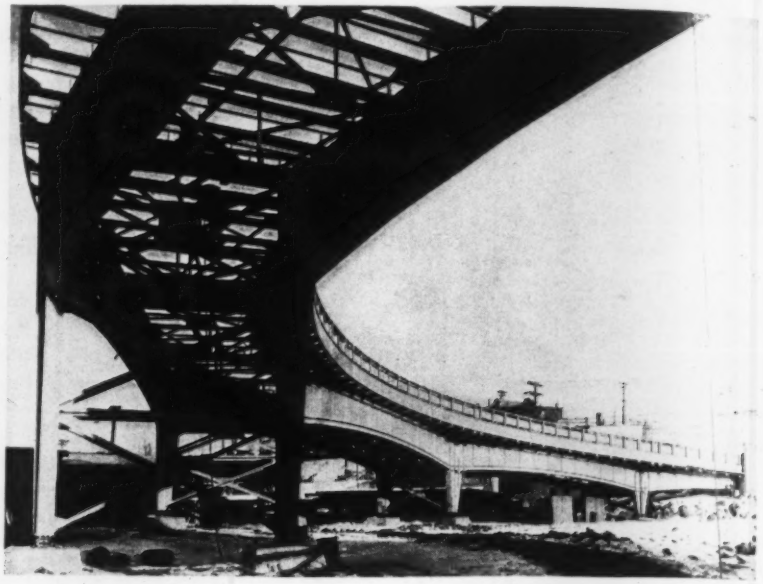


Fig. 6. Girders for the circular ramp section run straight from bent to bent, while the roadway follows a regular curve.

Fatigue Tests On Connection Angles

Connection angles which attach the stringers to floorbeams in through-truss railway bridges are subject to flexural stress due to (1) changes in length of bottom chords under passage of trains, and (2) vertical deflections of stringers under wheel loads. These movements result in bending of the outstanding legs of the angles and consequent tension on the rivets in these legs. Tests of the magnitude of these deflections to which the outstanding angle legs can be subjected a number of times without failure of the angles or rivets are recorded in Bulletin 317 of the Engineering Experiment Station, University of Illinois, by Wilbur M. Wilson and John V. Combe.

In the study of the results of the tests, the fatigue strength is taken as the maximum stress to which the part may be subjected two million times without fracture when tested on a cycle in which the total load varied from zero to a maximum tension. The average fatigue strength of the tension rivets was 16,000 and 20,000 lb. per sq.in., with 6 x 4-in. angles having the 4-in. legs outstanding. The average fatigue strength in flexure of 6 x 8-in. angles with the 8-in. legs outstanding (as riveted to the floorbeam) was 50,000 lb. When the specimens were loaded to their fatigue strength, the longitudinal movement of one stringer relative to the other (twice the movement of each one relative to the web of the floorbeam) was 0.0069 in. and 0.0024 in. for the 4 x 6-in. angles of 9/16 and ¾-in. thickness respectively, and 0.063 in. for the 6 x 8-in. angles ⅝-in. thick. It is explained that the number of tests was not sufficient for any general conclusions.

Los Angeles Plans to Spend $32,000,000 for Handling Sewage

Contents in Brief—Trunk sewers in which sewage travels as much as 55 miles have been heavily overloaded in Los Angeles by rapid population increases. Relief measures recommended by a consulting board include treatment plants, new trunk sewers, ventilation for old sewers and a new ocean outfall.

PROBLEMS IN SEWERAGE and sewage disposal in the city of Los Angeles have attained major proportions in recent years by reason of increased population as well as deterioration of some of the old outfall sewers. To get expert advice on these problems, the city retained a board of consulting engineers consisting of Samuel A. Greeley, Chicago; Charles G. Hyde, Berkeley, and Franklin Thomas, Pasadena. In its recommendations, this board listed needed improvements in two classifications: (a) immediate and (b) deferred.

Items in the former classification are estimated to cost a total of $17,580,000; the latter $14,060,000. Out of this total of $31,640,000 some $9,670,000 is for improved sewerage. An interesting detail is the recommended extension of the plan for ventilating trunk sewers where deterioration has been caused by hydrogen sulphide gas. The city now operates an exhaust fan of 22,000-cu. ft. per min. capacity which has dried out the arch of the north outfall sewer and apparently has stopped serious disintegration there.

The report stresses the advisability of making improvements now of the sort that will not have to be abandoned as the city's sewage disposal requirements expand. To make the plan far-reaching, the board estimated population increases for the next 40 years and made provision accordingly. "Outstanding above all other considerations," the report states, "is the desirability of reclaiming for unimpaired public use the considerably-more-than-a-mile-long frontage of city-owned beach at Hyperion . . . . now subject to contamination from the discharge of screened sewage into the waters of Santa Monica Bay."

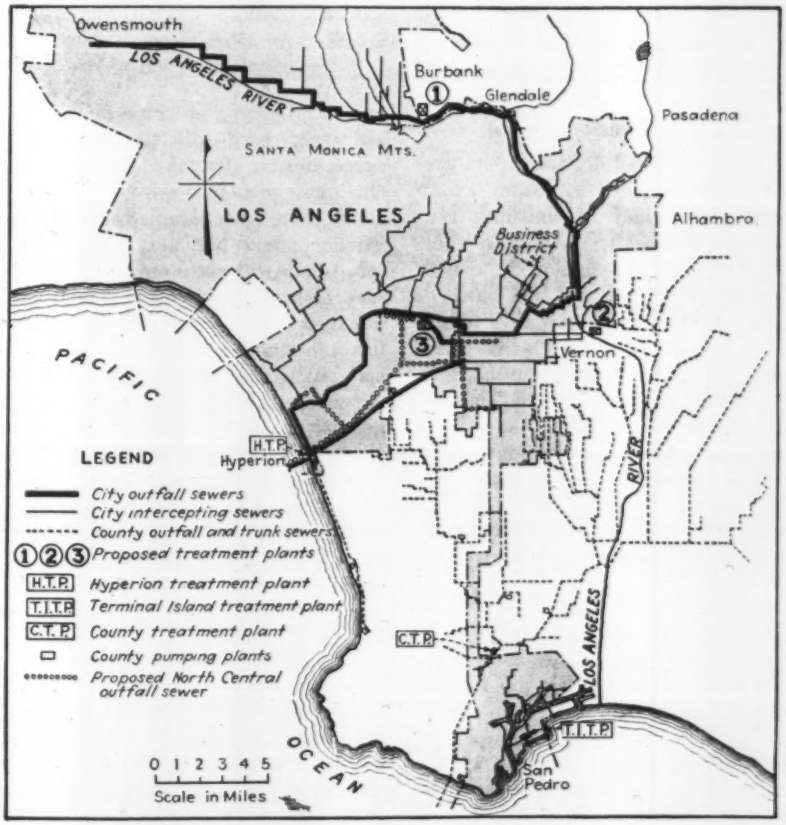
The board believes that ocean beaches in the vicinity of Los Angeles have inestimable recreation value. However, if present sewage disposal plans were to be continued, within the period covered in the estimates of this report, sewage from a tributary population of 4,000,000 would be discharged into the ocean at one point (Hyperion) and would result in increasing menace to beaches. Under the plan of using inland treatment plants, the quantity of maximum flow ultimately discharged into the ocean would be little more than at present (423 sec.-ft. in 1980) and with a new ocean outfall 5,000 ft. long supplemented by a modern treatment plant at the shore end, adequate beach protection is expected.

Recommendations made by the board in "immediate" and "deferred" classifications are listed in the accompanying table.

Because of the overloaded condition of the main trunk sewer, in which sewage collected near Owens-

ITEMIZED RECOMMENDATIONS IN THE IMMEDIATE AND DEFERRED CLASSIFICATIONS

	Immediate Construction	Deferred Construction
Land Outfalls		
Repair of central & north central outfall sewers	$1,632,000	.....
Ballona Creek relief overflow structure		
Construction of north central outfall sewer	.....	$7,200,000
Sewage Treatment		
At Hyperion (immediate, 170 mgd; deferred, 80 mgd; total 250 mgd)	5,580,000	2,880,000
At treatment plant No. 1 (immediate, 35 mgd; deferred, 25 mgd; total, 60 mgd)	3,348,000	1,940,000
At treatment plant No. 2 (immediate, 40 mgd; deferred, 10 mgd; total, 50 mgd)	4,308,000	780,000
New Ocean Outfall at Hyperion (675 sec.-ft.)	1,200,000	.....
Relief sewers in 14 districts	1,512,000	.....
Enlargement of north outfall sewer	.....	1,260,000
Totals	$17,580,000	$14,060,000



Location of improvements proposed for Los Angeles sewerage system.

mouth travels 55 miles before reaching the ocean at Hyperion, relief should be provided, the report states, by constructing two activated sludge plants immediately, one in the lower San Fernando Valley where the effluent could be spread on gravel beds and another near Vernon where the effluent could be discharged into the Los Angeles River channel. By the diversions made in these plants, the total sewage flow would be materially decreased.

A third plant, shown on the map as No. 3, is a still later possibility, not yet needed but worthy of future consideration. It would be well, the board advises, to buy the land now and build a small plant there just to hold the rights. The estimates are thought to be sufficiently generous to include the cost of this plant.

The problem as a whole is somewhat complicated by the fact that there are now 19 communities and districts, outside the Los Angeles city limits, which discharge sewage into the ocean at Hyperion. In estimating the location and density of future population increases, the board based its figures on forecasts made by the city engineer. Total population of the area tributary to the Hperion outfall is estimated to be 4,000,000 by 1980; the present figure is 1,590,000. The average daily flow of sanitary sewage is now 82 gal. per capita; in estimates of future needs, this has been increased to 85 gal. Peak flows (including storm water) have been as high as 205 gal. per capita; in future planning these are estimated at 212 gal.

The prediction of future population growth is recognized as particularly difficult because of the large areas now used principally for agriculture which could change quickly (already have changed in some cases) to densely populated areas. Best example of this is San Fernando Valley with an average population of 0.06 per acre now; this is expected to have increased to 2.3 per acre by 1970.

Progress Notes from Roadbuilders

***Contents in Brief**—Completing the review* (ENR, *Feb. 8, p. 204*) *of technical papers and committee reports presented at the annual convention of the American Road Builders Association at Chicago, Ill., Feb. 2–9, 1940, the following extracts indicate notable developments in equipment and methods that were presented for discussion.*

VIBRATED CONCRETE PAVEMENT

MISSOURI in 1937 began the general use of vibration as an alternate method of finishing concrete pavement. The vibration alternate permits a reduction in cement content of only 0.1 bbl. per batch of concrete, which amounts to a saving in material of 3c. per sq.yd. This saving goes to the department as it is reflected in the bid price. The saving to the contractor, if any, is in reduced labor costs. Although stiffer mixes are used than under other methods, the vibrator assists the finishing machine to strike off the mass of concrete and permits the movement of larger loads which would otherwise require shoveling. We do not have available data upon which to estimate cost savings to contractors but it is significant that the alternative of using vibration was a controlling factor in all competitive bidding. Using the more workable combinations of aggregates such as rounded quartz sands with gravel or crushed stone, no finishing difficulties are experienced with the use of an excess mortar content of 50 per cent. On experimental work satisfactory results have been obtained with much harsher mixes but, for the average job, which will not warrant the strict surveillance practiced on investigational projects, an additional safety-factor is desired. For this reason 50 per cent is the minimum excess mortar content (volume of mortar above that required to fill the voids in the coarse aggregate divided by the volume of the voids in the coarse aggregate) for the most workable materials with increases in this figure for harsher aggregates—F. V. REAGEL, *Missouri Highway Dept.*

CONCRETE PAVING SPREADERS

Wider pavements and increased output of paving mixers are opening a wider and more profitable field for machine spreaders. The construction of the Pennsylvania Turnpike, requiring a high daily yardage of concrete with a consistency from 1¼ to 1½-in. slump, offers an ideal example of the value of this spreader. On this work the allowable output of a 34E dual drum paver is about 100 cu. yd. per hr., equivalent to 300 lin. ft. of reinforced 12-ft. slab, 9 in. thick. Production approaching the limits allowed is being reached. Hand-spreading of the concrete of this consistency together with striking off 2 in. below the forms for reinforcement would be impossible in such cramped quarters if the full capacity of the paver is to be maintained.

The concrete spreader is a power-driven four-wheel frame with suitable forward and reverse speeds, on which is mounted a reversible 14-in. spiral screw which manipulates the concrete to one side or the other at the will of the operator. The concrete is dumped on the subgrade from the paver bucket at regular intervals and the spreader screw moves through the pile, breaking it down and distributing it laterally first in one direction and then in the other, so that hard piles are broken up, stone pockets eliminated and the final result is a uniform distribution of the concrete throughout the slab. At the same time, additional mixing of the concrete is provided which with the usual mixes of from 2 to 3-in. slump should practically eliminate the necessity of

hand-spading at the side. The screw behind which a strike-off plate is fixed, may be quickly adjusted vertically so that strike-off at the desired height is obtained.—LION GARDINER, *Jaeger Machine Co., Columbus, Ohio.*

FOG COAT TAR SEALS

On plant-mix surfaces a fog coat of the same grade of tar as used in the mixing operation is applied after the final rolling to seal the surface which has dried somewhat in the spreading and rolling operations. This application is at the rate of from 0.1 to 0.15 gal. per sq.yd.

It has been discovered that surface treatments are generally unnecessary the same year as construction. Instead, a light fog coat, without cover, is applied to the surface within a month after completion of the wearing course and traffic permitted to use it as soon as sufficiently dry to prevent picking up. Some of the 1937 construction was handled in this manner and left untreated until 1939 with no apparent ill effect. It is possible that, with a light fog coat every two years, surface treatments may be delayed at least five or more years after construction. — C. L. HANSON, *Highway Superintendent, Kane County, Ill.*

CONTRACT WORK EFFICIENT

The fundamental advantage of the contract system is based on human nature. Any man will naturally work harder for his own interest and advantage, especially if he has his own personal fortune at stake. If he is merely representing someone else's interests, it is human nature that he will perhaps not be as sincere in his efforts as he would be operating for his own personal benefit. A foreman on a job who realizes that every dollar saved will be an additional profit to himself will have quite a different attitude than if there were no rewards or penalties and the profit or loss in the job were not forcibly felt by himself. This, principally, is the reason why a contractor can handle an operation more efficiently than a man operating as a superintendent and working for a public body.

The fact that the WPA in numerous instances is now turning toward contractor supervision of certain items of work on relief projects is an excellent current example of the need for organized, efficient supervision on day-labor projects. The chief criticism of the WPA program throughout the nation is the delay and terrific costs of the improvements which have been made when compared with similar projects which have been done on a contract basis. —PAUL L. ANDREWS, *Executive Secretary, Georgia Highway Contractors Association.*

STREET RAILWAY TRACK ADVANCES

One of the few new developments in roadway and track construction this year is a new type of track designed and built by the Philadelphia Rapid Transit Co. in Philadelphia. Every fourth tie is of standard length with three short ties between under each rail. Concrete is vibrated between ties and over the base of rail. The pavements used were block, asphalt and concrete, although other types of pavement can be easily adapted.

The longer ties used were 5 x 9 in. x 8 ft. and the shorter ones 5 x 9 in. x 2 ft. 8 in. The use of the shorter ties allows for additional concrete in the center of the track area which usually carries the heavier vehicular loads.

Using this type of construction the tie spacing was increased from 22 to 24 in. and it is believed that the spacing can safely be extended to 28 or 30 in.

The use of the monolithic concrete slab for track reconstruction and surface pavement is rapidly coming into favor. This is due to the fact that most track construction in the past adapts itself readily to the use of concrete, and due to the development of vibration it has been proven that this type of construction more than any other prevents the entrance of water which has been the cause of most failures in track as well as in the adjoining structures.

The use of vibrated concrete under and around the rails in track structures has shown that the tie spacing can be increased and has also developed the fact that Tee rail can be utilized as well as the girder type with a resulting longer life. This means less track renewals and less inconvenience to the traveling public. One of the outstanding developments in the vibration of concrete has been in resurfacing or retopping various types of pavement the surface of which has become worn.

After first scarifying the surface with a scarifying machine a mixture of concrete, with a low water content and an aggregate of a size not over 50 per cent of the thickness of the surface to be installed, is applied with a pressure vibrator in thicknesses varying from a feather edge to 2 in.

Both processes of scarifying and pressure vibrating can be done in production. Cores taken after installation of from one to several years show a perfect bond between the new top and the old pavement surface. This type of topping has also been applied in repairing bridge floors both as a surface and as a base application under waterproofing. This same type of pressure vibrator has also been used successfully in finishing new concrete pavement in track areas.

In track reconstruction and maintenance today, it is common practice to vibrate concrete under and around the rail base. The type of pavement surface to be used governs the height to which the concrete is brought up on the rail. If concrete surface pavement is used it may be placed in one or two courses. The pressure vibrator has been used in applying the top or surface course. The first course which is vibrated in place by a track vibrator may of necessity be concrete with a slump of 3 to 5 in., depending on the size of aggregate used and the space between the rail and the old foundation. The surface course should be concrete with a very low water content and it has been demonstrated that concrete with a slump of 1 in. can be placed by the pressure vibrator with very little hand labor. Both the scarifier and pressure vibrator can be gasoline-operated and are now self-propelled.—*Report of Joint Committee on Street Railway Track and Pavement Construction.*

. . .

Engineering Emblem Wanted

A school of engineering is asking for suggestions for an emblem to symbolize its field and function. At present it is using a triangle and T-square combination in its seal, but thinks that this does not express adequately the scope of engineering. What can our readers suggest?

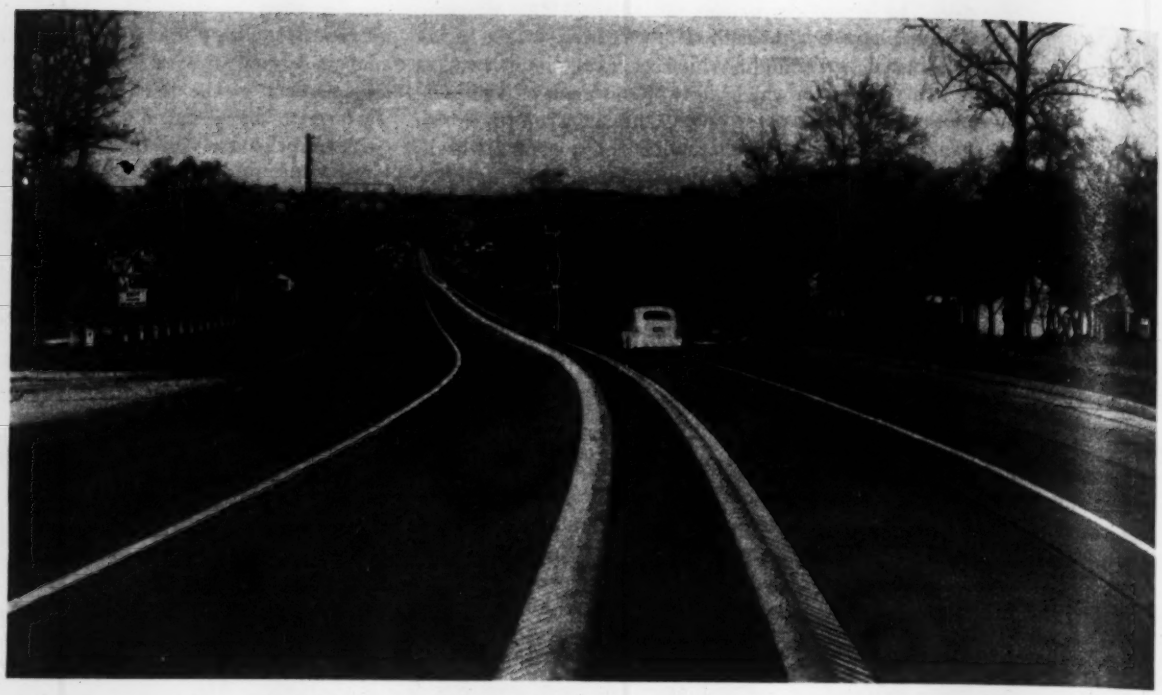


FIG. I. REFLECTING CURB AND MEDIAN STRIP PAVING USED ON RECENT NEW JERSEY DIVIDED HIGHWAYS.

Divided Highway Design—II

Design of Median Strips

Contents in Brief—Trends in the design of separating strips, the most distinctive element of divided highways, are outlined. In practice, widths are found to be a compromise. Rational study as yet has not been applied to any element but the determination of safe turning widths at intersections. Cross-profiles and types of curbs vary widely.

IN DISCUSSING PRACTICE in cross-profile design and dimensions for divided highways (*ENR*, Dec. 21, 1939, p. 816) illustrations were given of various forms of separating or median strips. The logical development of this part of the divided road is its distinctive design problem. Pavements, shoulders and roadside borders call for no special consideration other than in two lane roads except that somewhat greater transverse dimensions and a modified arrangement for surface drainage are involved. The design problem of the median strip depends on what its primary purpose is considered to be.

At its inception the only purpose of the median strip that was in mind was to provide a barrier between opposing currents of traffic on twin roadways. This conception was soon broadened to regard the median strip not only as a safety barrier but also as a neutral zone between traffic streams wide enough to protect turning traffic at intersections. As a barrier, the design problem is structural; as a protective measure for turning traffic, design becomes an adjustment of relationships between vehicle path and speed, width of neutral zone and length of intersection gap. These relationships in the design of median strips for turning safely at intersections were analyzed in *Engineering News-Record*, Oct. 26, 1939, p. 534, and the numerical values arrived at are summarized in a succeeding section.

Beyond these determinations, which apply only at intersections, highway engineering has no rational standards for median strip width. Practice recommends and normally has sought a median strip as wide, within reason, as is practicable. Several reasons have influenced this desire for width: increased safety and particularly an increased feeling of safety by drivers due to distance of separation from opposing traffic; ease of construction and maintenance; better opportunity to develop attractive landscaping, and certainly, back of all, an understanding of the greater protection that width gives turning traffic at intersections.

Width normally a compromise

But in the examples of divided roads that we have, width of median strip has not often been open to free choice. Width has been governed by right-of-way, cost of construction and cost of maintenance, but most often by assumed or actual restrictions of right-of-way. Practice thus gives us median strip widths ranging from 4

ft. to 50 ft. or more. Often it shows the graded roadway crowded too close to the right-of-way boundaries in order to secure median strip width. This is not accepted procedure in good design thinking which, as stated in the previous article, includes ample roadside borders in good cross-profile design.

While narrowing of roadside borders at the sacrifice of flat ditch and backslopes and roadside erosion control is not recognized good design, practice is quite charitable in approving the narrowing of median strip to meet right-of-way restrictions. Few existing divided highways have throughout a uniformly wide median strip. Commonly over bridges, in underpasses, in built-up communities or where cut-and-fill place a heavy cost penalty on graded roadway width, narrowing even to a single curb is held justifiable and is practiced.

New rational data

Purely for barrier purposes this variation in median strip width offers no great objections. A 4 to 6 ft. median strip, which is about the narrowest that practice in general considers desirable, offers, so far as width of separation is an element, reasonable safety to straight-away traffic. A greater width is safer and, as is noted later, greater width is desirable for other reasons. Width becomes a definite safety measure in case of turning traffic as at intersections or, less commonly, at other selected turning points.

Past practice has gone little farther in recognition of safe width at intersections than an assumption that something like 20 ft. or more will protect turning vehicles. In 1939 a study of the possibilities of rational design was reported by a committee of the Association of State Highway Officials. The determinations, which are too recent to be reflected in past practice, give the future designer his first rational data on median strip width. Omitting all reasoning leading to conclusions, the actual figures are as follows:

In the committee study, highways were divided into three classes as regards character of traffic: *P* denotes highways on which the traffic is exclusively passenger vehicles or the character and percentage of trucks using the highway have little effect on the movement of passenger ve-

Fig. 2. Dished median strip with paved gutters leading to valley catchbasins on the Governor Ritchie Highway in Maryland.

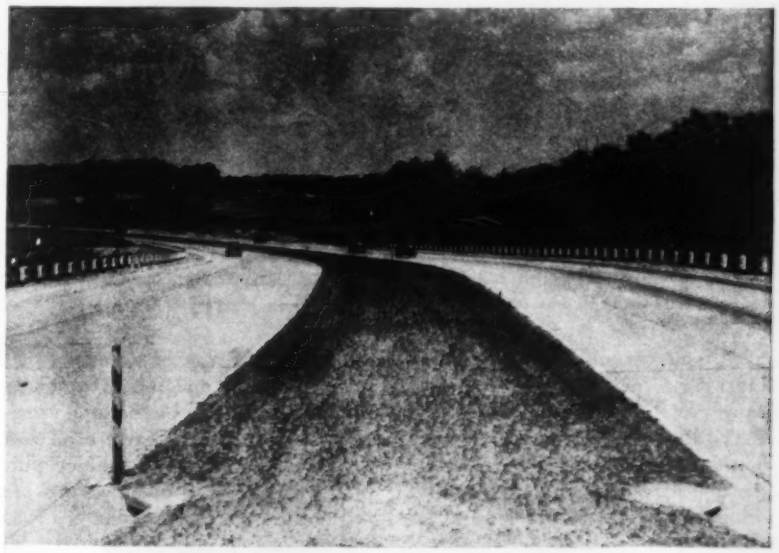


Fig. 3. Philadelphia Road in Maryland is an example of a wide crowned median strip draining to inside gutters and catchbasins.

Fig. 4. A 20-ft. median strip is narrowed to 10 ft. to pass under an overhead bridge on this Massachusetts six-lane divided highway.

hicles; *T* denotes highways on which the percentage of trucks is so high and the character of truck traffic is such that the speed of traffic is reduced frequently and passenger vehicles are confronted with the problem of passing slower-moving vehicles frequently, and *M* denoted mixed traffic in which slow-moving vehicles impede traffic only occasionally. Most highways are in the *M* class.

The desirable width of median strip at grade crossings is at least 25 ft. for *P* traffic, 32 ft. for *M* traffic, and 43 ft. for *T* traffic. These widths combined with proper lengths of opening provide full protection for all crossing and all left-turning vehicles, and accommodate nearly all U-turning vehicles. The occasional heavy unit U-turning on a four-lane divided highway may have to use the shoulders. The proper lengths of opening in combination with these widths are 67 ft., 98 ft., and 87 ft., respectively. Compromise lengths of opening in combination with these widths are 50 ft., 78 ft., and 67 ft., respectively.

Where the desirable widths of median strip cannot be obtained the median widths may be reduced to 19 ft. for *P* traffic and to 30 ft. for *M* and *T* traffic without a material sacrifice in protective features. These widths of median strip combined with proper lengths of opening provide full protection for crossing vehicles and for all left-turning vehicles in the opened area, but vehicles which turn left onto the divided highway must begin the turn in the face of opposing crossroad traffic before reaching a protected position in the median area. The proper lengths of opening in combination with narrow strips are 73 ft. and 100 ft., respectively. Compromise lengths of opening in combination with these widths have been set at 56 ft. and 80 ft., respectively.

Fig. 5. A typical slab-paved narrow median strip on a divided highway through a Rhode Island city.

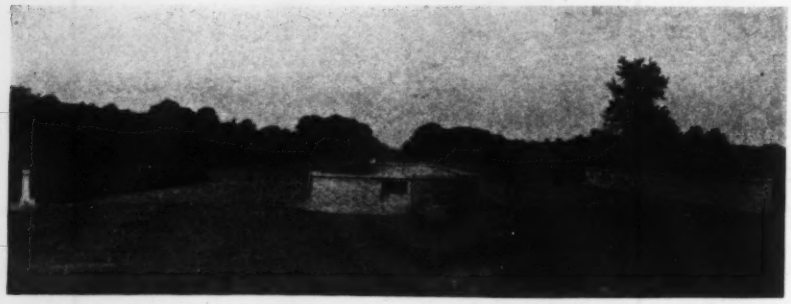


Fig. 6. Twin bridges with common "bathtub-type" inner railing continue median strip over stream crossings on the Philadelphia Road in Maryland.

While widths of median strips less than 19 ft. and 30 ft. for *P* and *T* traffic, respectively, will not afford full protection for cross-traffic, these narrow widths in combination with proper lengths of median opening may be utilized to afford full protection for left-turning movements.

Current structural design

Comment so far has related to geometrical design. As structures, median strips fall into two classes: Raised strips between curb edgings and flush strips without curbs or having very low curbs of the lip type. A following article will consider curb design and construction in detail; here comment is confined to practice and to opinion on general type. Besides curbs the structural elements

Fig. 7. Rustic paving (left) and median strip structures to preserve trees on two Maryland roads (right) are examples of esthetic surface treatment.

are surface and drainage structures.

Curbs—Dividing curbs and particularly edge curbs introduce possibilities for side-swiping and collision. On divided roads this potential danger is reduced by widened traffic lanes and by special curb shapes and heights. As practice regards shape and height, the high, vertical-face urban-type curb is generally out of consideration. Instead some form of curb-section that will permit vehicles to mount the curb in cases of necessity, with a minimum of hazard, is sought. It is not considered practicable or safe to construct a curb sufficiently high to prevent vehicles from jumping over it except in specially restricted and limited areas. A preferable method is to use the low-curb section that can be mounted and, as a barrier, to keep the opposing lines of traffic as far apart as highway conditions will permit by widening the median strip. Experience also has indicated that the average motorist will not usually drive as closely to a vertical curb as he will to one with a sloping face. Therefore to make more effective use of the traffic surfacing, it is desirable that curbs have a 45-deg. or flatter sloping face and that the height be kept moderate. It is generally considered that a range in height from 3 to 5 in. will be found most suitable, with an average of 4 in. generally satisfactory for drainage and other requirements. In general, the inclined curb is more visible, and in recent practice, as will be developed in another article, visibility is being given intensive study.

Surface—Practice presents so great a variety of median strip surfacing that only general trends can be indicated. Broadly classified, surfaces are paved or planted and the illustrations show examples of each kind. Paving is confined to narrow, 4 to 6-ft., strips but planting, in practice, is not restricted as to width, grass and low-growing ground cover being used on 4 to 6-ft. strips. On wider strips planting is universal practice. In general good plant growth is more difficult to obtain and maintain on narrow strips and there are authorities who for this reason maintain that, for planting, strips less than 10 ft. wide should not be considered.

Pavement for narrow median strips is most commonly a concrete slab constructed on earthfill between the curbs but practice includes a variety of surfacing materials. Recently attention is being given to coloring and surface finish partly for ornamentation but largely for improved visibility or to reduce specular reflection. Some of these special light-reflecting surfaces will be discussed in a following article.

In cross-profile, practice leans toward a crowned surface, but dished surfaces are common, particularly for wide flush median strips. Structurally, the essential difference is in the drainage. Crowned strips, generally curbed, drain each way to the passing or inside-lane gutters to which the passing lanes drain. Dished strips generally with flush edges drain to the center and also take the run-off of the passing lanes to the center. Here paved center gutters lead to catchbasins in the valleys. In general, drainage of divided highways is the problem that has not been solved in a manner satisfactory to the general run of highway engineers.

Water Waste from Leakage

Two brief papers on leakage in waterworks systems are given in the *Over-the-Spillway* bulletin of the Illinois state department of public health. While leakage surveys are expensive and city councils often consider the cost too great, it is pointed out by C. E. Corrington, commissioner of public property at Clinton, Ill., that the councils fail to look beyond the first cost. But the cumulative savings of a few months, due to prevention of leaks, may more than offset the original cost of the survey. He classes leaks as follows, in order of importance: (1) abandoned services; (2) broken gooseneck connections; (3) leaks in old galvanized piping; (4) defective valves; (5) leaks in mains.

The entire distribution system should be metered, so that the amount of leakage may be known. At Clinton, the leakage at one time amounted to 270,000 gallons daily, but since survey and repairs there has been a saving of $7,000 yearly. Steps to be taken to keep leaks at a minimum were as follows: (1) have recording meters at the plant calibrated so that accurate measure of the flow can be obtained; (2) have all pumps checked and regulated; (3) have every consumer (paying or non-paying) metered; (4) keep careful records of daily pumping; (5) keep daily records of flow for sewage treatment; (6) compare total meter readings with plant recording meter; (7) have each fire hydrant tested every three months; (8) have detail plans of the complete distribution system, with positive location of every valve; (9) use a leak detector.

Water leaks and water unaccounted for was the subject of a paper by A. P. Kuranz, superintendent of the water department at Waukesha, Wis., who classified water unaccounted for as follows: (1) leaks in mains and services; (2) slippage and under-registration in meters; (3) water used in public buildings, schools, churches, fire department, and street and sewer flushing. Ordinarily, 5 per cent of pumpage can be charged to leakage in the mains and 9 per cent to service leaks. Slippage usually averages not more than 5 per cent. Thus the water department should sell about 81 per cent.

Slippage and under-registration in meters brings up another problem, because the average house service is a ¾-in. line and has a ⅝-in. meter, while the actual use of water in the home does not begin to reach the maximum capacity of either the service pipe or the meter. Thus the superintendent should not be concerned with domestic flows of more than 2 gpm, as most are from ¼-gpm to zero. In the average home, one drop per second from a leaky faucet amounts to about 7 gpd. The toilet flush valve accounts for approximately 90 per cent of leakage.

According to Mr. Kuranz, to improve the revenue of the utility, the simplest and most economical way is to begin at the meter. For the money invested, the loss due to under-registration and slippage in meters can be more easily recovered than in repair of mains or service leaks.

More Profit From Suction Dredges

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Contents in Brief—Notes from the author's operating experience, particularly suggestions for safeguarding estimates and more closely analyzing operation of suction dredges. Examples of actual operating figures show how slight changes can make large differences in performance.

SCARCITY of technical literature on the operation of suction dredges and transporting materials in pipes 14 to 27 in. in diameter has led the author to record some of his own observations on how to obtain efficient and hence profitable operation of suction dredges. In practice so many variable factors enter that the results of experiments in the laboratory or on models can be applied in the field to only a very limited extent. But it is essential to profitable operation that the engineer in charge be able to analyze the operations on any given job as it progresses. Aid to this end, it is hoped, will be found in the following practical suggestions and the illustrations of their application.

Successful dredge performance

The key to successful suction dredge performance is a knowledge of (a) the average unit weight of the mixture of water and solids flowing in the pipeline, (b) the rate at which it is flowing and (c) the amount of power being used. Knowing what these values are, together with experience as to what they should be for the material being dredged, gives a basis from which to judge the efficiency and effectiveness of operation under way. A similarly detailed knowledge of the performance of which the particular dredge in question is capable is a necessary prerequisite to reliable estimates of probable performance on any contemplated work.

Under ordinary operating conditions, the values for weight of mixture, loss of head, velocity and power expended in the pipeline all change momentarily and all show wide variations. Since estimates must be based on averages, the specific values used in making estimates must be truly representative of performance over a considerable period of time.

For any given mixture there will be some minimum velocity below which it is impossible to operate without plugging the line. At this velocity the mixture will be transported with the least expenditure for power, but overall economy usually calls for higher velocities, and of course the mixture can never be kept uniform. Hence the dredging problem deals rather with the question of what actually should be done rather than this theoretical relation between mixture and velocity. For any given mixture to be dredged, when there is efficient operation, the weight of mixture pumped should fall within narrow and well defined limits.

Where the mixture has been obtained by stirring a finely divided material, such as a mud or silt, in salt water, a fluid weighing seventy-six lb. per cu. ft. is about the heaviest that can be expected. Ordinary sands should yield mixtures weighing seventy-four lb. Mixtures from clays, gravel and cobbles usually weigh 68 to 70 lb. Neither theory nor practice suggests that heavier mixtures could not be pumped, but ordinarily it is not practical to pump them. Many factors other than velocity influence the density of the mixture. (The weights mentioned are all averages. Heavier mixtures are pumped for considerable periods followed by periods when only water is delivered.)

Pipeline velocity

When pumping clear water, there are various means of determining pipeline velocity by direct observation, but when pumping mixtures the velocity will be lower, will be somewhat variable and difficult to determine with the degree of accuracy necessary to accurate analysis of performance. Observations made when pumping clear water are valuable in determining pump efficiency and as a check on calculations, but there is a method by which, when certain data are available, both weight of mixture and pipeline velocity may be calculated.

This is based on the fact that the energy put into the pipeline must equal that expended in the pipeline. Data needed for the computation are: (1) loss of head in pipeline, (2) original weight of material dredged, (3) suction lift, (4) static lift above pump, (5) power put into pipeline, and (6) rate at which yardage is moved. Of these, the original weight and static lift can be determined by direct measurement, while the rate at which yardage is moved may be determined by measuring up the hole excavated and the time required to do it.

Loss of head

Friction in dredge pipelines, when pumping material, has never been measured in the field with any accuracy, nor does it appear likely that any means will be devised whereby this can be done. However, laboratory experiments and theory indicate that, when the flow is *fully turbulent*, the loss of head, expressed in terms of a column of the fluid being pumped, will be the same for any mixture of water and solids as it is for clear water.

Flow in dredge pipelines seldom, if ever, complies with the condition of complete turbulency. Further, since the density of the mixture varies from the top to the bottom of the pipe, and from point to point along the line, attempts to apply theory to operating conditions are not convincing. However, by resorting to the concept of an *average* coefficient of friction and an *average* density of mixture pumped, computations may be made which have checked well with observed results. Loss of head is calculated by the formula

$$h = K \frac{V^{1.9}}{D^{1.1}},$$

where h is the loss of head in feet per 1,000 ft. of pipeline, D is the inside diameter of the pipe in feet, V is velocity in feet per second and K is a constant having a value of 0.4 for dredge pipelines containing the usual number of elbows and flexible connections. Solutions of this equation will be facilitated by the construction of diagrams drawn on logarithmic paper. This formula must be used with great caution. It has been found valid in some cases but it is known that pipe line conditions do not comply with the theory of turbulent flow and on occasion the values of "K" and of the exponents of "V" and "D" have been quite different from those given.

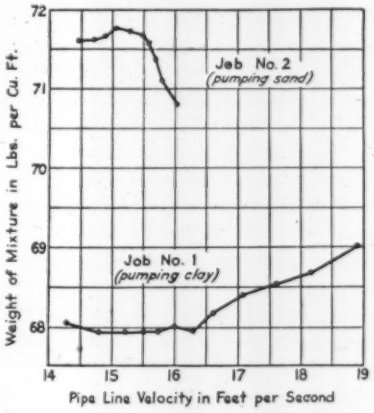
Suction lift

The total head or lift against which the pump works is the sum of the vertical lift above the pump, the suction head, and the friction head loss in the pipeline. Of these, the vertical lift can be measured and the friction loss computed by the above formula. Owing principally to the high entrance losses, the suction head cannot be determined by any fixed rule. Usually the digging vacuum on a dredge is between 22 and 23 in., corresponding to a head of 23 ft. of a mixture of average density, and in dredging estimates a lift of 23 ft. should be used to account for all work on the suction side of the pump, including the creation of the velocity head.

Power put into pipeline

The power actually expended in the pipeline, of course, equals that put into the pump less pump losses. No accurate means for determining the efficiency of a pump while it is pumping a mixture is readily available and it is best to assume that this is the same as when pumping water. Well designed dredge pumps in good condition frequently show efficiencies of 70 per cent, although 65 per cent is doubtless much closer to the average. Impellers of freak design intended to facilitate the passage of very large objects may give substantially lower efficiencies, and the rapid wear experienced in all dredge pumps sometimes has a marked effect on performance.

All centrifugal pumps show wide ranges in efficiency as head and discharge vary but when properly proportioned they should show a nearly constant efficiency through the range of conditions for which they are designed. Curves should be obtained for all pumps, should be checked frequently, and when making any analysis the efficiency corresponding to the head and discharge involved should be used. Where better information is lacking the author assumes an efficiency of 0.625.



Comparative values for dredge performance on two large jobs.

All computations on dredge performance involve the relation between density of mixture, gross volume pumped, and volume dredged. The ratio between volume dredged and volume pumped is often called the "percentage of solids" or the "volumetric ratio" but the term "place percentage" would be less ambiguous. Computations of this kind are most readily made by means of diagrams which are simple to prepare.

Once the velocity in the pipeline has been determined, the average weight of mixture which must have been pumped with the power used and the volume excavated can be computed. The simplest method of getting the pipeline velocity is to calculate the weight of mixture which the power actually used could have pumped at each of several assumed velocities and thus, by trial, finding a velocity - weight combination which will agree with the measured rate of dredging and power consumption.

To illustrate the method of making an analysis, the records of two well-supervised jobs performed by the same equipment are presented in the accompanying table. Each job involved moving several million yards of material. The measured data are averages of many observations taken during the progress of the work. On one job the material was fairly easy to dig but unusually difficult to pump. Material in the other job was not exceptionally hard to pump but required much power to dig.

Dredge performance is best studied by plotting weight of mixture against velocity as has been done in the diagram reproduced herewith. Examining the results for Job No. 1, it is at once apparent that for this particular material the velocity reached a critical value at 16 fps. At lower velocities the weight of mixture remained constant at close to 68 lb. Once the critical point was passed, however, the weight increased in direct proportion to the velocity, a relation which held true as far as the record extended. Undoubtedly the dredge could have dug more, and a heavier mixture could have been pumped at higher velocities. Extending the curve indicates that a mixture weighing 70 lb. probably could have been

TABLE I — PERFORMANCE RECORDS ON TWO LARGE SUCTION DREDGE JOBS DONE WITH THE SAME EQUIPMENT

Job No. 1

Material:
10 per cent bay mud weighing 85 lb., 90 per cent stiff blue clay weighing 130–135 lb. Calculated average weight for job, saturated with salt water, 138 lb.

Pipe (ft.)	Measured Cu. yd. per hr.	Power (kw)	Calculated Velocity (fps)	Mixture (lb.)
4,000	780	2,700	18.9	69.00
4,500	710	2,700	18.2	68.70
5,000	660	2,700	17.6	68.55
5,500	620	2,700	17.1	68.40
6,000	570	2,700	16.6	68.15
6,500	540	2,700	16.3	67.95
7,000	525	2,770	16.0	68.00
7,500	505	2,840	15.8	67.90
8,000	500	2,860	15.5	67.95
8,500	490	2,840	15.2	67.95
9,000	480	2,770	14.8	67.95
9,500	480	2,690	14.3	68.05

Job No. 2

Material:
17 per cent bay mud weighing 85 lb., 83 per cent very hard, very sandy clay weighing 128 lb. Calculated average weight for job, saturated with salt water, 121 lb.

Pipe (ft.)	Measured Cu. yd. per hr.	Power (kw)	Calculated Velocity (fps)	Mixture (lb.)
4,000	1,020	1,830	16.1	70.80
4,500	1,050	1,940	15.8	71.14
5,000	1,080	2,070	15.7	71.40
5,500	1,100	2,200	15.6	71.58
6,000	1,100	2,320	15.5	71.68
6,500	1,100	2,420	15.3	71.73
7,000	1,090	2,500	15.1	71.77
7,500	1,060	2,560	14.9	71.65
8,000	1,040	2,600	14.7	71.61
8,500	1,020	2,620	14.45	71.60

Values identical for both jobs were: pipeline dia., 27 in.; digging vacuum, 23 in.; terminal lift, 14 ft.; motor eff., 0.90 per cent; pump eff., 0.625 per cent.

pumped at a velocity of 21.5 fps. At this rate the output of the dredge would have been 1,080 cu.yd. per hour.

Note that at all times the dredge was exerting very close to its maximum power. Estimates showed that to maintain the output at the rate of 780 cu.yd. per hour at all distances up to 9,500 ft. would require a maximum of 5,800 kw, while to maintain an output at the rate of 1,100 cu.yd. per hour (the rate attained on Job No. 2) would require a gross pumping power of 3,860 kw for the 4,000-ft. line, a demand which would rise to 8,340 kw when the delivery distance reached 9,500 ft. The additional pumping capacity could have been provided by means of boosters, but it was found that cost of installing and operating would have far exceeded the additional revenue earned. The dredge was doing all that it could and measures to improve the performance would not have been profitable.

Different conditions on Job 2

The plotted results on Job No. 2 show an entirely different state of affairs. While there is some suggestion that velocities below 15 fps were not sufficient to maintain a mixture of maximum weight, the evidence is not conclusive, but there is a distinct drop in density of mixture once a velocity of 15 fps is passed and the rate of decrease increased noticeably beyond the 15.6-fps velocity.

Where the weight decreases with rise in velocity, while the output of the dredge remains constant, this is because the digging limit of the dredge in this particular material has been reached. Raising the velocity merely draws in more water, dilutes the mixture and wastes power, without increasing the earnings.

Once a velocity of 15.6 fps was passed, not only did the weight of mixture decrease at a higher rate, but the hourly output of the dredge began to decrease also. This indicates one of the more serious troubles to which a suction dredge occasionally is subject. Although the causes are too complicated to be discussed within the space limits of this article, it is obvious that pipeline velocity should not be allowed to rise to a value which will actually lower the output of the dredge. In the present instance, the velocity in fact was limited about as closely as was practical.

The performance of a dredge on a prospective job may be predicted by selecting a weight of mixture compatible with the nature of the material to be dredged, and then calculating the velocity which the available power will be able to maintain in the required pipeline. Experience must be relied upon to be certain that the velocity which can be obtained will be high enough to carry the selected mixture and yet not so high that suction-pipe troubles may be expected with the dredge to be used. Also it must be known that the dredge can cut the estimated amount.

For such estimates a knowledge of the weight of the material in situ is often of paramount importance. For example: many soft mud deposits appear to be of almost identical consistency, yet their weight may vary between 85 and 100 lb. per cu.ft. A dredge using 1,800 hp gross on the pump will be able to pump a 74-lb. mixture through 5,000 ft. of 24-in. pipe against a lift of 14 ft. at a velocity of 13.7 fps. If the material weighed 85 lb., output would be at the rate of 2,800 cu.yd. per hour, but if the weight were 100 lb. the output would be at the rate of 1,600 cu.yd. per hour.

Economy of operation

In any given situation, the dredge output will be limited by its digging capacity or its pumping capacity; seldom will the two be found in perfect balance. The method of analysis outlined in the foregoing will enable the operator to determine whether or not the dredge is being operated at capacity and what feature limits this capacity. Having this information, it is not difficult to make analyses that will show whether the best velocity is being used and whether steps to increase the capacity of the dredge will be profitable.

Factors to be watched

It is not always most profitable to operate a dredge at full capacity. Detailed estimates should be prepared in each case to show the financial results of operation at various rates of output. Care should be taken when preparing such estimates to include all items of dredging cost. Frequently overlooked are such items as stand-by expense while the dredge is idle, interest, depreciation and overhead.

When no other work is in immediate prospect for the dredge, frequently it will be better to keep it running on a single shift rather than to complete the work in the shortest possible time and then lay the machine up for a protracted period.

The wear, for various velocities, in pump and pipeline warrant study; this will be found to vary with the material handled. Sometimes velocities higher than would otherwise be economical will avoid dragging so much material along the bottom of the pipe as to cut it to pieces rapidly. In other cases, high velocities may be attended by extremely rapid wear in the pump and undue cost for replacement of parts.

Irrigation Increased in India

Irrigation in 13 provinces of India was increased by 1,282,100 acres in the year 1936-37, bringing the total to 32,256,100 acres, as stated in the annual report of the Department of Labor, Government of India. This area represented 13.8 per cent of the total area of land sown for crops. Nearly 12,000,000 acres are irrigated by wells, which total 2,535,365 in number. In the Ganges valley, 592 tube wells were sunk, raising the total to 1,348 out of the 1,500 wells planned. Extensive projects are under consideration, but the great project for impounding the waters of the Tungabhadra River is still delayed by rival claims to a share of the water by the local governments of Mysore and Hyderabad. This is in addition to the financial and technical difficulties. In Bengal, the Damodar Canal was extended 10½ mi. to a total of 348 mi., this extension being credited with saving a great amount of crops from destruction. On the Ganges River, six hydro-electric plants are in operation, with a total peak load of 13,000 kw., serving 3,957 mi. of transmission lines, with 208 main substations and 1,415 rural substations. Research work of the Irrigation Research Institute, in the Punjab, includes: (1), a study of silt accumulation in relation to slope and cross-section of channels, and (2) uplift pressures on weirs of submerged dams.

Mono Craters Tunnel Completion Ends Struggle With Hard Driving

***Contents in Brief**—Los Angeles has driven a tunnel 11.3 miles long directly through ancient volcanoes where extreme faulting and shattering with heavy water inflows made the job difficult; large quantities of carbon dioxide gas complicated the work.*

MONO CRATERS TUNNEL is a major feature in the project to divert water from Mono Basin into the drainage basin utilized, through the Owens Valley Aqueduct, for domestic water supply in the city of Los Angeles. The tunnel is about 350 miles north of Los Angeles and is designed for a capacity of 365 cfs. Operated intermittently in connection with storage reservoirs above and below, it is expected to add to sources already developed about 145 cfs, which will make it possible to operate the existing Owens Valley Aqueduct at its capacity of 480 cfs.

Construction on the project started in July, 1934, financed by bond issue and carried on under the direct supervision of the city's own engineering organization. In addition to the long tunnel, the development includes construction of two earthfill storage dams (at Grant Lake and at Long Valley) as well as various canals, conduits and control works. In the 11.3-mile tunnel, driving was completed early in 1939 and the concrete lining was completed near the end of the year. An account of methods used in handling the heavy inflows of gas was published in *Engineering News-Record*, Feb. 24, 1937, p. 285. The following observations on the tunnel driving problems were taken from a paper by H. L. Jacques, engineer of major construction, Department of Water & Power, Los Angeles, read at a recent sectional meeting of the American Water Works Association.

To avoid excessive length, the tunnel had to be located where it would pass under a group of volcanic cones 9,000 ft. or more in height known as Mono Craters. These cones are of relatively recent origin and there was much speculation as to what the headings would encounter in passing directly through volcanic vents.

Now that the work is done, records show extreme variation; for 3½ miles of its length the tunnel traversed formations so broken that changes from hard to soft and vice versa occurred within a few feet. There were fissures filled with loose material, open crevices from which came enough water temporarily to flood the tunnel and zones of high water pressure that caused run-ins filling the tunnel for as much as 100 ft. at a time. Warm springs (97 deg. F.) traversed for more than 2 mi., were charged with carbon dioxide to such an extent that means had to be devised to make the atmosphere in the tunnel livable for workmen.

Three shafts were put down to shorten the driving time by increasing the number of headings. In the deepest shaft (No. 1; depth 826 ft.) a soft formation, largely ash, was extremely difficult to hold because it would seep through the lagging or boil up in the bottom, sometimes filling the shaft for considerable depths. Completing this shaft was finally aided by a 12-in. well drilled from the bottom of the completed portion to tunnel grade. During the period of sinking, the average flow into the shaft was about 550 gpm; at times considerably more. When the shaft was finished, it was agreed that it would have been economical to have sunk a well (say 12-in. diameter) in which a deep well pump could have facilitated drainage. This plan was used successfully at shaft No. 2.

Where the worst water and gas inflows were encountered, holes were drilled into the face before drilling for blasting and the heading was grouted under pressures of about 1,000 lb. per sq.in. By using quick-setting cement for the grout, the ordinary drilling and blasting at the face could follow immediately after grouting had been completed. Grout holes were drilled 40 ft. deep and after grouting, about 20 ft. would be shot out. By thus assuring at least a 20-ft. grouted wall ahead of the face at all times, the risk of run-ins when approaching soft or broken ground was decreased.

Further to reduce the dangers of cave-ins, the water pressure was released by drilling holes in walls and roof back of the face. Pipes in these drill holes conveyed water and gas to pumps, thereby reducing the amount of water on the tunnel floor and decreasing the escape of gas from water into the tunnel air. The maximum water inflow for all headings was a little more than 20,000 gpm or 44 cfs.

Combating gas inflows

For a long time, the gas inflow averaged 1,000 cu.ft. per minute. About 40 per cent of the CO_2 usually was retained in the water and the remainder escaped into the air in the tunnel. The volume of liberated gas depended considerably on atmospheric conditions; a great increase in the rate of escape into the air occurred during a rapidly falling barometer and there was a corresponding decrease when the barometer was rising.

Daily analysis of CO_2 and oxygen percentages in tunnel air were used to govern procedure aimed at keeping the CO_2 percentage below 2½ and the oxygen above 20.5 per cent. When large flows of water rushed into the tunnel, gas was sometimes liberated at such a rapid rate that the air became saturated to 15 or 20 per cent and despite the delivery of 8,000 cu.ft. per minute of fresh air close to the face, the gas inflow forced the miners to leave the face even when a run-in was impending from heavy ground, water or gas pressure.

The tunnel section is almost circular (about 9½ ft. inside concrete lining; 11 ft. inside temporary timbering) and the gradiant is 0.0005.

Due to the flat gradient and small width of tunnel, drainage water had to be picked up at close intervals; usually 1,000 ft. apart. Where CO_2 came in in large volume, it was necessary to decrease this pump spacing to reduce the escape of gas from water into the air. The carbon dioxide proved to be particularly corrosive on steel. Pick-up pumps required runners and casings made of bronze; any of the other materials tried lasted only a short time.

Electric Drive for Ordinary Jobs—II

Selecting the Motor for the Work

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***Contents in Brief**—Available types of motors are the squirrel cage and wound rotor. Squirrel cage is best for constant-speed operation. In larger sizes it requires a compensator to reduce current for slow starting. Also it may be operated at different speeds by varying number of poles. Wound rotor motor is best for adjustable speed and for high starting torque. Motor ratings as based on safe temperatures for the windings and should be adhered to.*

THE MOTOR is the driving unit of the electrified machine, its heart. It, therefore, must function to meet whatever load and speed conditions may characterize the work of the machine. The choice of a motor for an excavator or a concrete mixer is then a precise task. Generally it is a task that the contractor can best leave to the machine manufacturer, but the contractor should know that electrical engineers have designed motors of different construction and different power output characteristics to meet these various work requirements. Also he should know enough about various motors to judge their suitability for the particular work they have to do. To give this information is the purpose of this article.

As stated in the previous article (*ENR*, Feb. 1, 1940) virtually all commercial sources supply alternating current, and nearly all machines for construction are equipped with motors designed for this type of current. Where, for certain machines, direct current is preferable motor-generator units are introduced in the alternating-current job-distribution system to make the conversion. These units will be discussed in a future article; only alternating current motors are considered here. These are of two types—squirrel cage and wound rotor—and there are variations of each type.

Squirrel cage motors

For machinery that is to operate at a constant speed, the squirrel cage induction motor is generally used, being the simplest in construction, least likely to develop trouble and the cheapest to purchase and maintain. Due to its structure, there is nothing in a well-constructed squirrel cage motor to require attention other than to be sure that the bearings are properly lubricated. *Look out for worn bearings.* Also due to structure there is no way in which the windings can wear out. The only dangers to be guarded against are therefore mechanical injury and burning out caused by overload.

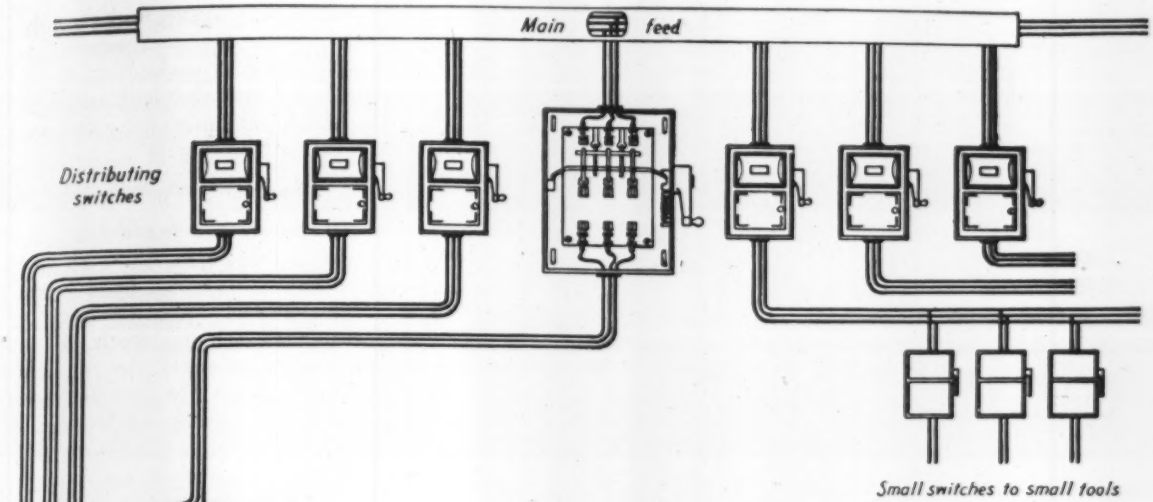
Squirrel cage motors are built for several starting characteristics. For work in which the machine is started without any load, the general-purpose motor may be used but, since most construction machinery is liable to be started under fully or partly loaded conditions, the high-starting-torque type is preferred. This design permits starting without the use of auxiliary current-reducing starting elements, and it may be employed in sizes up to 30 or 40 hp. The local utility station should be consulted in the matter of its use since different stations hold to a varying maximum of the horsepower of a motor of this type that may be thrown directly on their lines. Up to this limit, the motors may be started by simply closing a line switch, which is usually in the form of a pushbutton-operated, magnetic starter. One or more sets of pushbuttons may be installed at convenient points so that the control of the motor is remote if desired.

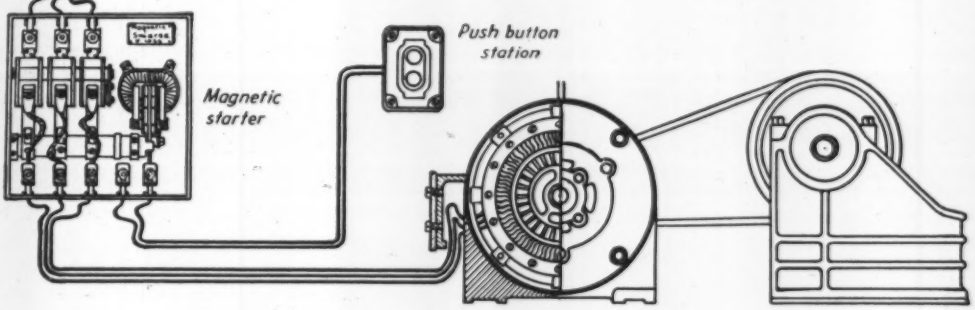
For squirrel cage motors of larger horsepower, some form of starter must be employed. The most common form is the auto-transformer compensator that effects slow starting and a reduction of starting current. Starting compensators are usually manually operated but can be obtained in automatic form when conditions warrant the additional cost. Practically all compensators are provided with a stop button in their casings the depression of which causes the circuit to open and the motor to stop. By placing other stop buttons in series with that in the compensator and locating them at convenient points a layout is provided in which the machine may be immediately shut down without the necessity of going to the compensator itself.

A modified type of squirrel cage motor, known as the multispeed, is frequently used where it is at times desirable to have the machine operate at a high speed and at other times at a low speed. Such operation, as will be explained later, may be obtained by the use of a wound rotor motor but, whenever such a motor runs at low speed, considerable current is wasted and the speed at these low points is unstable. Speed regulation of the multispeed squirrel cage motor is equally good at all running speeds.

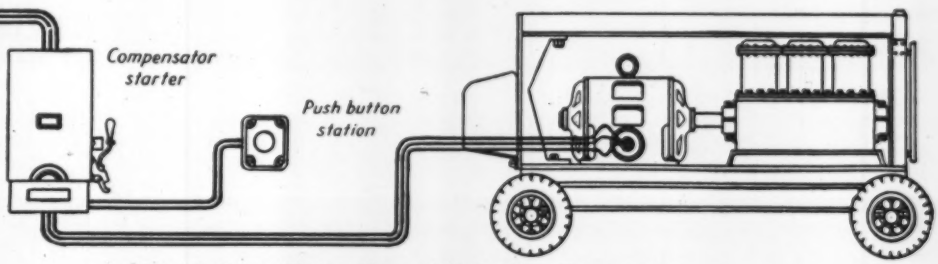
This speed adjustment is obtained by a selective grouping of the poles of the motor. A motor operating on a 60-cycle frequency will, if it is provided with eight poles, run at a synchronous speed of 900 rpm. If now, one-half of the poles are cut out of the stator circuit, the effect is virtually to make the motor a four pole machine which will run at a speed of 1,800 rpm. Similarly, connections which will render it the equivalent of a six-pole machine will result in a speed of 1,200 rpm. The number of speeds and the speed range may be varied or increased by the use of motors having more than eight

Fig. 1. Applying motors to familiar items of construction equipment. Switches, starters, and pole changers are correctly placed, and wiring diagrams are accurate.

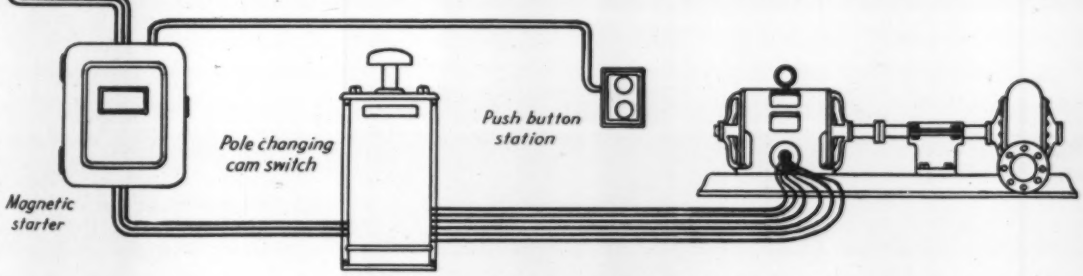




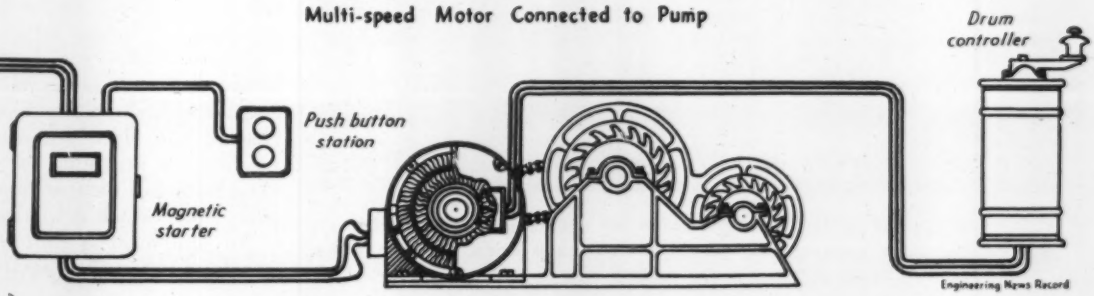
Squirrel Cage Motor Connected to Rock Crusher



Squirrel Cage Motor Connected to Air Compressor



Multi-speed Motor Connected to Pump



Wound Rotor Motor Connected to Hoist

poles. Thus, the ten-pole motor has a base speed of 720 rpm and one of twelve poles a base of 600 rpm. The multispeed motor most generally used for construction machinery is rated at 900/1200/1800 rpm, as these three speeds are found to cover all common requirements.

Multispeed squirrel cage motors

In the choice of a motor of this type care must be taken to select the one in which the output characteristics correspond to the demands of the work to be done. Three types of multispeed motors are available known respectively as constant horsepower (at any speed), constant torque (at any speed) and variable torque (in which torque decreases with speed). Constant horsepower motors are employed on a machine in which the load is heavy at slow speed and light at high speed. Variable torque motors are employed for the operation of such equipment as ventilating fans for tunnels, mines, etc., where the power required varies with the cube of the speed. A typical motor of the variable torque type would be rated 2.5/4.4/10 hp., 900/1200/1800 rpm.

Although the selective grouping of poles in a multispeed motor involves certain complications of internal wiring and connections, from the standpoint of the user the operation of such a motor is as simple as that of a constant-speed motor. All the additional equipment required is a simple pole-setting switch which, by turning a knob, makes the necessary connections for the particular speed desired. When this switch has been set for any speed, the motor is started and stopped by a pushbutton switch or compensator in exactly the same manner as a single speed machine.

Wound rotor motors

The wound rotor motor, sometimes incorrectly referred to as the slip-ring motor, is provided with a rotor that is wound with wire, hence the name. Connections to the rotor windings are brought out to a set of collector rings mounted on the armature shaft. Through the collector rings and their brushes connection is made to exterior resistance arranged in steps so that the amount of resistance in the rotor circuit may be adjusted at will.

The extremely heavy torque which is developed by this type of motor when operating with high resistance makes it particularly suited for machines that must be started under full load or overload as is the case with hoists. By use of proper steps of resistance the wound rotor motor may be run "on the resistance steps" at speeds below normal, and an adjustable speed feature thus obtained. An inherent objection to the wound rotor motor is instability of speed especially when much resistance is retained in the circuit for adjusted speeds. This means that the speed will change with any variation of load. In operating a constant-speed machine this is undesirable but with material handling machinery this feature may be of value since, if a load is hard to start when slow speed is applied to the motor, the speed will pick up as friction and inertia are overcome, and acceleration to normal speed is then readily accomplished.

For the control of wound rotor motors in construction work the manually operated drum controller is most generally used. With it the speeds are controlled by a movement of the handle over the connection points on the drum.

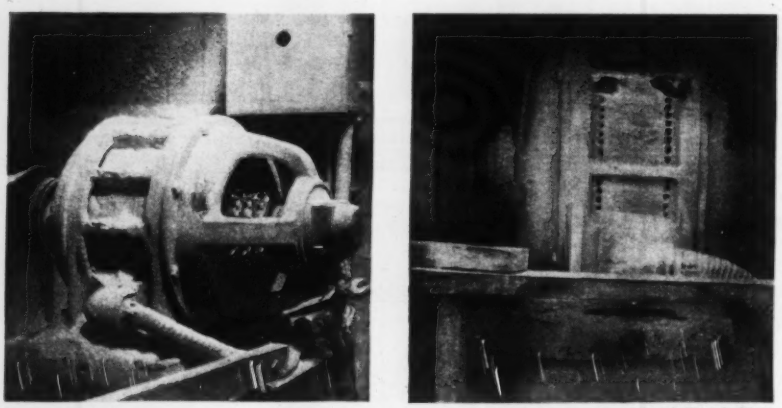
Common power ratings

The horsepower that a motor develops is based upon the temperature that its windings can stand safely. Although a 10-hp motor may be capable of exerting nearly 20 hp such operation would cause its windings to burn out. For general-purpose motors the limiting temperature is based on a 40-deg. C. (104 deg. F.) rise above ambient air, and such motors will continuously carry 15 per cent overloads without injury. This will explain why the horsepower rating of a diesel or gas engine applied to any specific piece of machinery will usually be found to be greater than that of a corresponding motor when applied to the same machine.

Certain classes of work, such as the operation of hoists and cranes, are more or less intermittent so that higher temperature limits are allowed for short periods since the motors will have time to cool off during the intervals of work. The basis of intermittent ratings that have been standardized for open-type, wound rotor crane motors up to and including those of 40-hp, 900-rpm ratings, is that the full load temperature rise for 30 min. shall not exceed 50 deg. C. (122 deg. F.), while those larger than the above rating shall carry their full load for a period of 1 hr. without exceeding the same rise in temperature. When the user can be assured that there will be ample time between periods of operation for the motors to cool off, crane motors may be used advantageously on other types of construction machinery where the service is intermittent.

The motor should, of course, have sufficient power to perform successfully all work that will be imposed upon it, but it should not be so large that it is constantly operated at much less than its normal rating. Such a condition makes for lowered efficiency and poor power factor. This emphasizes the importance, when purchasing any electrified construction machine, of providing the manufacturer with full data as to all conditions under which it will operate.

No equipment is entirely trouble-proof, and electrified equipment has



General Electric Photos

Fig. 2. Two types of motors—wound rotor on left and squirrel cage on right—in a rock crushing plant, exerting their power through a belt drive. Both are 40 hp, the wound rotor operating at 720 rpm, the squirrel cage at 1200 rpm.

its troubles. These can be reduced by taking proper precautions in installation and operation. Fundamentally, it is wise, whenever a piece of electrified construction machinery is sent out on a job, to have it inspected by an experienced electrician.

Installation precautions

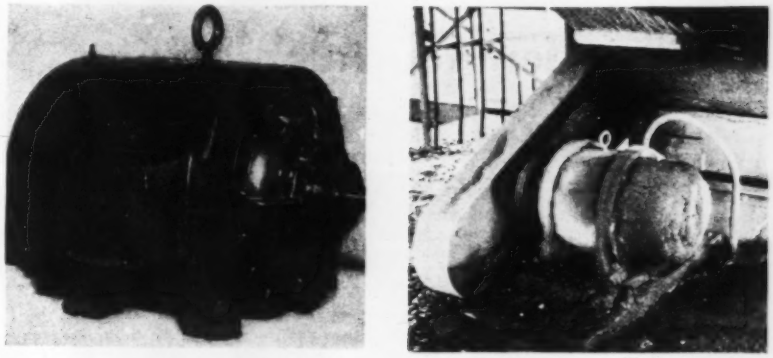
Trouble for electrical equipment may be electrical or mechanical. The former is most likely to take the form of burned-out windings. All starters and controls are provided with protecting devices which, if they are not tampered with, will cause the motor to shut down in case of overloads which might be injurious to the windings. Too often, however, when a motor is heavily loaded this protection may operate with a frequency that is annoying to the contractor who is more interested in the progress of the work than in the condition of the electrical equipment, so long as it runs.

There are ways, which will not be mentioned here, in which this operation of the overload protection may be thwarted. The motor will then carry the overloads until it burns out. The only correct remedy for a constantly overloaded condition is of course the substitution of a motor of adequate capacity.

Motor troubles arising from mechanical injury are damage from outside contact or that due to normal wear. In the squirrel-cage motor there is nothing to wear out except the bearings. These are most liberally designed on all makes of motors but they must be occasionally oiled and even the best-constructed bearing will wear out in time. Wear will occur more rapidly in applications in which the motor drives the machine through flat or V-belts or through chain drives, which impose a pressure on one side of the bearing heavier than on the rest of the surface. With direct-connected motors the wear is usually at the bottom of the bearing which carries the weight of the rotor and coupling or shaft. When the construction job is located remote from any source of repair parts it is advisable always to have a set of replacement bearings on hand.

In the rough and dusty conditions which characterize most construction jobs there is always the possibility of the equipment being injured by dirt or moisture. When the machine is installed in a temporary shed it is usually sufficiently protected against such damage so that the open type of motor and control may be used. When it must operate out of doors, however, an enclosed type of equipment, both motor and control, should be used. Protected equipment is provided in water-proof, weather-proof, dust-proof, splash-proof, oil-proof and explosion-proof construction.

The next article in the series will discuss electric power application to pumps and air compressors.



Westinghouse Photos

Fig. 3. Totally enclosed motors for severe operating conditions. View at right shows a motor in service in an aggregate screening plant.

What is Filter Alum?

This question is answered in a bulletin of the Illinois State Department of Public Health, on the authority of Dr. Buswell, chief of the State Water Survey. It is explained that misunderstandings occur because the term "alum" may refer to a number of different substances. This was not serious in waterworks affairs in earlier days, because in most cases the term "alum" or "filter alum" was used merely to indicate the commercial form of aluminum sulphate which was commonly used as a coagulant. More recently, the use of various forms of ammonia to form chloramine has led to the introduction of "ammonium alum". Occasionally, "true alum" is used in very small installations.

In chemical language the term "alum" refers to a crystallized material composed of the sulphates of a three-valent metal such as aluminum, iron or chromium, and a single-valent metal or ion such as sodium, potassium or ammonium, together with water of crystallization, (water combined with the salts in the crystal so that even when powdered the crystal appears dry). The typical example of this class is potassium aluminum sulphate. In early days this was the only soluble form of alumina readily available in commerce. The chromium and iron alums are important in chemical industries, but not in waterworks.

The "true alum" or potash alum was expensive, largely because of its potash content, which was not necessary for coagulation. For that reason, the manufacture of aluminum sulphate was developed and came into wide commercial use. Because it was a substitute for "true alum" it was still so called, and in waterworks fields it was referred to as "filter alum". Ammonium alum is the ammonium aluminum sulphate and is a "true alum". It is sometimes used in water purification because the ammonium ion forms chloramine which in the aluminum reacts to form a floc for clarification. No confusion will arise in the waterworks field if the term "filter alum" is used to mean ordinary commercial aluminum sulphate, and "ammonium alum" and "potassium alum" when referring to either of the less commonly used coagulants.

Plugs for Aqueduct Testing Formed from Steel Plates

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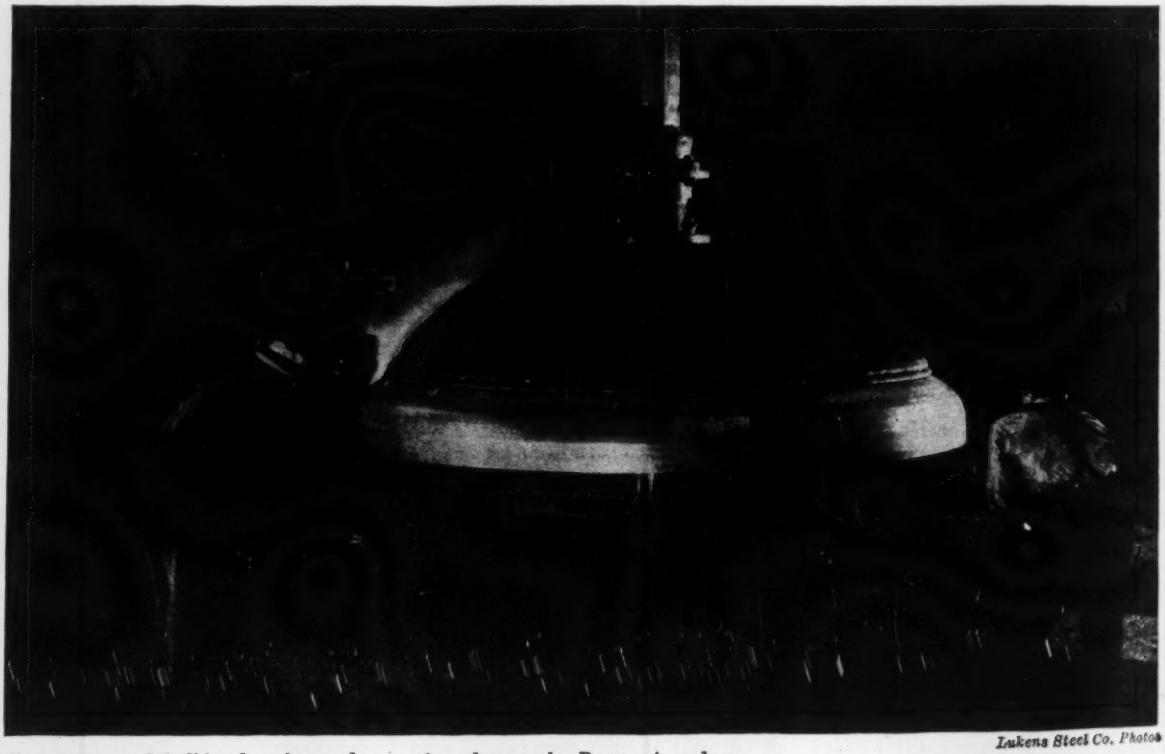
Contents in Brief—To isolate sections of the new Boston pressure aqueduct temporarily when tests are made for watertightness, bulkheads of steel formed in one piece will be used. These plugs, which are strong enough to resist a hydrostatic thrust up to 160-ft. head, can be easily installed and removed.

ROLLED STEEL BULKHEADS are being used to close off and take the hydrostatic thrust in sections of the new Boston pressure aqueduct when tests are made to determine watertightness. The use of steel heads, which are made from one piece of steel formed to shape, was determined to be the simplest and most economical method to isolate the sections of the pressure pipe for test purposes.

The 17½-mile aqueduct being built by the Massachusetts Metropolitan District Water Supply Commission (*ENR*, Aug. 31, 1939, p. 283) is divided into six sections, each section being constructed under a separate contract. One of the sections is a tunnel, and the other five are cut-and-cover aqueducts built of precast reinforced concrete steel-cylinder pressure pipe. The pipe is of very large size, two miles of it being 12½ ft. inside diameter, and 13 miles being 11½ ft. in diameter. Each section of aqueduct will be tested separately for watertightness, the leakage requirement being that, under full working hydrostatic head, the 24-hr. total shall not exceed an amount of 75 gal. per mile of pipe per inch of internal diameter.

Dished bulkhead which was made in one piece formed to shape. It is one inch in thickness and has an outside diameter of 11.81 ft.

Two bulkheads have already been installed on sections about 6.3 mi. apart. Each bulkhead is designed for a test head of about 125 ft. of water and the aqueduct at the bulkheads is designed for working heads of about 100 ft. A third bulkhead designed for a head of 160 ft. will be placed in another section where the working head is about 130 ft.



Lukens Steel Co. Photo

Forming a steel bulkhead to be used as a pipe plug on the Boston Aqueduct.

The bulkhead in place plugs the pipe for testing purposes. The head is welded around the circumference to the steel cylinder which forms part of the wall of the pipe. The valve in the bottom is for drainage, and the inlet at the top is for air.

In aqueducts of similar construction but of smaller diameter the testing is customarily done behind structural steel or timber bulkheads built across the pipe waterway and embedded in recesses in the pipe walls. In this large diameter aqueduct, however, an adequate design of timber bulkheads would be so complex and unwieldy as to be out of the question, due to the large area of waterway subjected to the end hydrostatic thrust during testing. Structural steel bulkheads were rejected because they would be exceedingly heavy and expensive, as well as difficult and costly to install and remove.

The use of the rolled steel heads as shown in the accompanying photographs offered a happy solution to this problem. Each steel head was made in one piece formed to shape, but one of these was cut in half in order that it could be carried into and installed in the conduit after the pipe was laid. The halves were welded along the vertical diameter. The heads were welded around the circumference to the steel cylinder cast in the pipe. This welding was done in a recess cast inside the pipe, leaving the steel cylinder of the pipe exposed for that purpose. The completed head has a valve built in the bottom for drainage and an inlet in the top for the passage of air.

Upon completion of the test the steel head will be burned out around the circumference close to the pipe wall. Recesses in the pipe left for the installation and removal of the heads will be plastered or united with cement mortar, smoothly finished.

The plate thickness of the two bulkheads for the 125-ft. test head is $\frac{3}{16}$ in. and the total weight of each completed unit in place is about $5\frac{1}{2}$ tons. The thickness of the third bulkhead is $1\frac{3}{16}$ in. and the total weight about 7 tons.

The bulkheads were manufactured by the Lukens Steel Co. of Coatesville, Pa., and they were installed by the American Concrete and Steel Pipe Co., of Los Angeles, Calif., contractors on the pipe laying.

Stabilizers in Water Treatment

Until within the past two or three years, attempts at reducing scale formation in piping of municipal water supplies have been by softening, in which the scale-forming substances are actually removed from the water. But this method has not always been successful. More satisfactory results are attained by recarbonation, but the transition range between a scale-forming water and a corrosive water is often narrow and difficult to maintain. New phosphate compounds exhibit the unusual property of stabilizing water; that is, the water is neither scale-forming nor corrosive. The calcium or encrustment material is not removed but is held in suspension. The mechanics of this action is not yet known. This statement as to the stabilization of water is condensed from a paper read at the 1939 meeting of the South Dakota Water and Sewage Works Conference, and published in *The Clarifier*, bulletin of the State Board of Health.

It is stated that these phosphate compounds have been known for many years, but only used in municipal water supplies within the past few years. Sodium hexametaphosphate is the most widely used. The pyrophosphates and polyphosphates seem to possess the same characteristics. Two South Dakota plants use the metaphosphates in dosages of 5 lb. and 8 lb. per million gallons, respectively. This phosphate is best fed as a solution, the chemical being highly soluble. Results have been demonstrated in lime-softening plants having two or more filters, by feeding the stabilizer to the water entering one filter and then checking the alkalinity of the filter effluent against that of the other filter. Ordinarily a filter bed will remove 15 to 30 ppm. or 1 to 2 grains per gallon of carbonate hardness. At Aberdeen, S. D., in the effluent from the filter treated with 0.2 ppm. of phosphate, the alkalinity was 54 to 68 ppm., while in the filter with no phosphate it was 28 to 38 ppm. This shows that an average of 29 parts of carbonate alkalinity had been held in solution by the phosphate.

The treatment can be applied equally well to untreated groundwater. On some small plants the treatment with stabilizers may dispense with the need for recarbonation, where the water can be softened with little or no excess lime. The cost of treatment with stabilizers is small. The phosphates range from 12 to 20 cents per lb. and with wider use the price will be reduced, bringing the cost of treatment to about $1.00 per million gallons.

Toll Parkway Proposed for Los Angeles

***Contents in Brief**—As the initial project in a $250,000,000 traffic relief plan for Los Angeles, consultants propose a six-lane, six-mile parkway from downtown northwest to Hollywood to be built with toll refunding revenue bonds. Because the city needs mass transportation facilities as much as it needs express highways the new parkways would be designed to accommodate buses.*

TRANSPORTATION NEEDS of the Los Angeles metropolitan area have been the subject of intensive study for the past year and a half by a transportation engineering board that has been working out a plan for adequate express highways and developing a basis for handling all phases of the rapid transit problem. Although the outlined scheme is a very comprehensive one and would cost some $250,000,000, it is not the plan to begin on the entire program at the outset. The idea, rather, is to start with one of the more necessary units, finance it with revenue bonds and operate it temporarily as a toll road. This is expected to introduce the toll parkway plan in a way to create a demand for more units of the program. The toll method, to be used only for initiating the project, is expected to make the improvement self-liquidating as long as the toll basis continues.

The problem before the board was twofold in character because both private automobile and mass transportation systems had to be considered. There are about 1,000,000 automobiles in the Los Angeles metropolitan area and in addition the public transportation systems carry about 1,000,000 passengers daily. Because of the considerable distances involved in the average suburban trip in an area of this size, surface transportation, confronted with traffic congestion and intersection stops, can make only about half the average speed desired. As population increases, more and more delay is caused by traffic congestion. In automobile test runs, 30 per cent of total time was lost in standing at intersections, and other serious and unnecessary delays were encountered.

Buses on the parkways

The plan for relief includes a system of express highways and arterial parkways to serve as the framework for a comprehensive transportation system. Rapid-transit buses would use the routes but would be required

Fig. 1. Of this proposed express highway net for the Los Angeles area, Hollywood Parkway is recommended for first construction, to be financed by revenue bonds and operated as a toll road.

to have pick-up, speed and braking facilities such as to avoid interference with private cars. All bus stops would be entirely out of traffic lanes; in fact, bus lines might have only portions of their routes on the parkways, picking up and discharging passengers on city streets. The necessity for assuming that buses must use the express highway facilities is pointed by the fact that the average number of passengers for each private automobile is only 1.5.

Although details of mass transportation by rail are left for later study, the board expresses belief that the best interests of the public are not served by municipally-owned transit systems. Rather, the plan outlined for the downtown district proposes a non-profit association that would combine and direct all existing traction agencies under one head. This association would be designed not only to unify and operate the several systems in the best interests of the public, but would plan needed rate changes, service extensions and in other ways see that the interests of the public get primary consideration.

Of the numerous parkway routes recommended for the ultimate network, the Hollywood Parkway was selected as the one best suited to initial construction. It would have a length of six miles, accommodate six lanes of traffic (75,000 cars in 24 hr.), and is estimated to cost about $20,000,000, including land, construction of the freeway, approaches, grade separations and landscaping. Standards of design would be for grades to be not more than 4 per cent (access drives not more than 5 per cent), curves to have radii not less than 2,000 ft. (200 ft. on access roads), sight distances over bridges 400 to 500 ft. and right-of-way width 250 ft. to permit of parkway landscaping. A center dividing strip of 35 ft. is proposed, to be available for an additional roadway or for installation of rapid transit tracks if they should be needed.

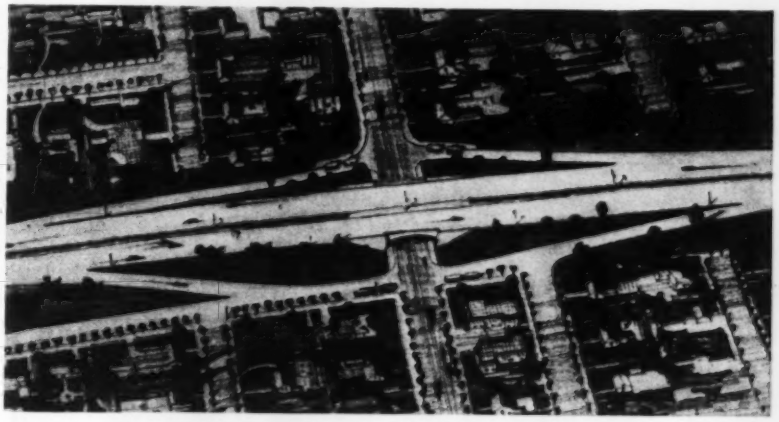


Fig. 3. Buses, operated on the parkway system to provide needed mass transportation, would be loaded and unloaded at off-parkway stations.

As shown in Fig. 2, this parkway would extend from the West Bypass to Cahuenga Pass, connecting two of the district's most important centers of trade and population, and it would be entirely within the jurisdiction of the city of Los Angeles. As a part of the project it is also recommended that a section of the West Bypass be constructed as far south as Eighth St. (5 blocks) to provide adequate access ramps and outlets in the central business district. Consideration was given to extending West Bypass northward to the present terminus of the Arroyo Seco Parkway, now under construction by the state, but it was decided that this construction should be deferred until the Arroyo Seco route has another outlet to the east which can take some of its traffic.

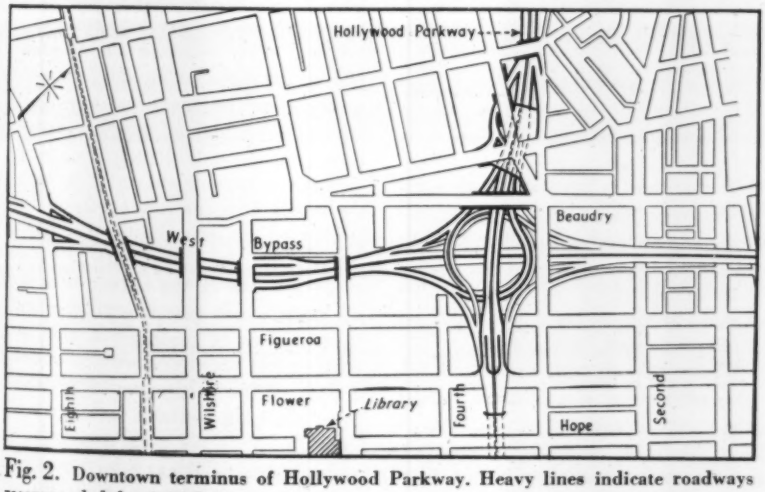


Fig. 2. Downtown terminus of Hollywood Parkway. Heavy lines indicate roadways recommended for initial construction.

In recommending that the Hollywood Parkway be made self-liquidating through tolls the engineering board states that while the toll method would hardly be practicable for a network system, as proposed, it should provide an excellent method of initiating the project.

The transportation engineering board includes Lloyd Aldrich, chairman, named by the board of public works of Los Angeles; K. Charles Bean, chief engineer and general manager, named by the board of public utilities and transportation, and the Stone & Webster Engineering Corp. named by the Citizens' Transportation Survey Committee which includes representatives from 27 nearby cities and suburban communities. Associates are Madigan-Hyland, consulting engineers, New York.

Prior to work of the transportation engineering board The Citizens Transportation Survey Committee, with funds allocated by the WPA, made a factual survey of very comprehensive scope. Results of this survey were used by the board in its analysis and recommendations. The board has reported to the city government but its findings apply to the metropolitan area, and the recommendation is that after the city has constructed the first unit that neighboring cities be invited to join in work of a more comprehensive scale.

Registration of Surveys Needed in Most States

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Contents in Brief—Inadequate registration of land titles and surveys at the time of title transfer creates considerable economic waste in many states. Although some states have initiated reform laws to eliminate some duplication in title registry, the author believes they are missing a further chance to avoid duplication of work when they do not legislate to require registration of surveys made in connection with these transfers.

REGISTRATION OF SURVEYS as well as registration of titles is an objective to be sought by those interested in reducing wasteful duplication in land surveying. Reforms in title registration laws have been initiated in many states, but they do not go far enough into the problem.

In the nature of things, land, first owned in large tracts, is divided successively into smaller and smaller parcels, so that when a chain of title is traced back from the present owner it quickly merges with many other chains of title. Each time a parcel is sold it is customary to make a new individual title search back through previous owners for some sixty years. Not only is the usual search a repetition of the previous search for the same parcel, but it duplicates a large portion of the searches for many other parcels.

This unnecessary duplication of effort creates a serious economic loss, particularly when deficiencies in the title are discovered.

Nearly similar conditions affect land surveys. The description of most parcels are necessarily based on rather indefinite landmarks. Few of the street lines mentioned in the deed are actually marked, and if marked, are seldom in their original positions. In the country the ties mentioned in the original notes are often destroyed long before they can be used. As a result, the land surveyor is never quite sure of the position of the property he is to survey nor of the exact location of adjoining parcels. Under such a system adjoining parcels seldom fit together nor can they be combined to make up the city block with which they must conform. As land increases in value, definite lines must be established, a process requiring costly surveys and considerable judgment. For this it is necessary to obtain the relative positions of all survey monuments, stakes, irons, fences, buildings, and what-not which give evidence of lines in possession throughout the whole or part of the city block or tract in which the one parcel to be surveyed is located.

By making a comparison with these marks on the ground and the descriptions found in the deeds the surveyor must work out some reasonable solution as his experience, ingenuity, and judgment dictate. As he cannot charge his client for most of this research, he must compile records of his work in the hope that later surveys in the same area will be a means of compensation. He thus compiles a set of records often spoken of as a "plant" and is forced to use secret marks on the ground to prevent others from profiting by his expenditures.

Duplications and disputes

It frequently happens that other surveyors working in the same city block will arrive at a different solution from his and sooner or later a boundary dispute results. Even if they should agree with him, they will have duplicated much of his work.

Where strong, well organized title companies exist, duplication in both title searches and surveys is reduced to a minimum and the opportunity for dispute is almost eliminated. Such companies maintain title plants and survey plants, or accept the work only of the surveyor who has the most complete plant for the neighborhood. However, where these companies do not operate, wasted effort is prevalent.

To remedy these conditions, many states have enacted laws called Torrens laws, under which title to real estate may be registered. Once registered, only current records need be searched. Unfortunately, none of these laws provides a means for registering the surveys. Such laws give proof to the title but as the customary survey and description is accepted as a means of defining ownership it is impossible to be sure of the location of the boundaries. The lack of this protection militates against the use of these systems and partly because of this few titles are registered.

A bill was introduced in the Connecticut legislature at the last session which, had it passed, would have provided for registered title, but without provision for registered surveys. The contemplated revision of the Torrens Act introduced in 1938 in New York contains this omission. The Pennsylvania legislature considered a similarly incomplete law a few years ago. Thus it is evident that those promoting title registration do not realize that survey registration is necessary.

Used in Massachusetts

Perhaps the most successful use of the Torrens system is found in Hawaii, the Philippines, and in Massachusetts. In the first two of these, plane coordinates based on geodetic triangulation are used as a basis for surveys. In Massachusetts, Judge Charles Thornton Davis, who is responsible for the great success of the system, early realized the necessity for survey registration and as a result a land court engineer was appointed, who, by requiring complete survey data and the establishment of interconnected durable survey monuments upon which the surveys are based, has prevented the possibility of disputes arising. Moreover, he maintains complete records of the survey data for all areas where title is registered and in his office is prepared a plan for each parcel registered which becomes a part of the certificates of registration. The plan contains far more data than appear in the usual descriptions, and supplies sufficient information for any competent surveyor to mark the property without further reference.

Computing Hydraulic Elements Of Irregular Cross-Sections

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BACKWATER COMPUTATIONS in rivers and streams are long and laborious partly because considerable time must be spent in computing the hydraulic elements of the stream cross-sections. It is advisable, therefore, to systematize the work as much as possible and to use any available shortcut which does not sacrifice the accuracy required. Here is a sample computation together with a shortcut for determining the wetted perimeter and hydraulic radius.

A typical stream cross-section is shown in Fig. 1 with horizontal and vertical scales as noted. Two curves giving values of the area and hydraulic radius as functions of the water surface elevation are desired.

The computations are set forth in the table. In Col. 2, elevations are entered at sufficient points to give a representative curve. The top width at each elevation is entered in Col. 3. Col. 4 shows computations for the area. Up to El. 510, the area is determined by planimeter or by "counting squares." Above El. 510, areas are determined as for a series of trapezoids, that is the average width times the height. The increment of area from a given elevation to the preceding elevation is shown in Col. 5 and the cumulative area in Col. 6.

Ordinarily, in obtaining the wetted perimeter it is necessary to solve for the hypotenuses of a series of right triangles; however, use of the diagram shown in Fig. 2a will lead to the answer much more quickly by giving the correction to be made to the top width in order to obtain the wetted perimeter. In using the diagram the procedure is as follows: Place the straight edge of the diagram so as to coincide with any straight-line portion, *AB*, of a cross-section. A horizontal line passing through the point *O* will give a reading, *K*, on the scale on the curved edge of the diagram; *K* multiplied by the vertical height of *AB* will give the amount which the true length *AB*

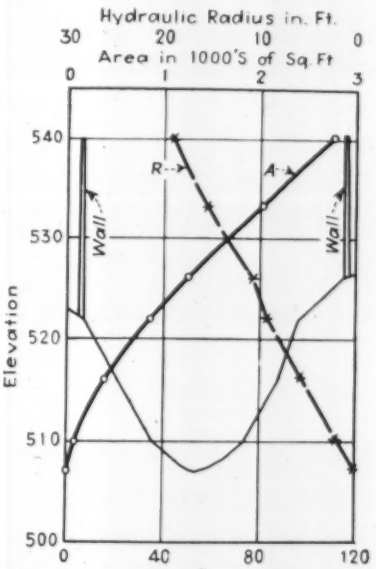

Fig. 1. Example of irregular cross-section showing computed curves of area and hydraulic radius. Abscissas are horizontal distances in feet.

is greater than the horizontal length of *AB*. Referring to the example, the diagram gives (El. 507 to 510): $K = 0.10$ for the right hand side and $K = 0.10$ for the left hand side; total $K = 0.20$; 0.20×3 (vertical height) $= 0.6$ ft. (Use 1 ft.) Between El. 510 and 516, $K = 0.20$ for the right hand side and $K = 0.20$ for the left hand side; total $K = 0.40$; 0.40×6 (vertical height) $= 2.4$ ft. (Use 2 ft.) This is the correction between El. 510 and 516. The total correction to El. 516 is $1 + 2 = 3$ ft., as entered in Col. 1. Similarly corrections are worked out for other elevations. The correction at any elevation plus the top width equals the wetted perimeter, Col. 7, and the area divided by the wetted perimeter equals the hydraulic radius, Col. 8.

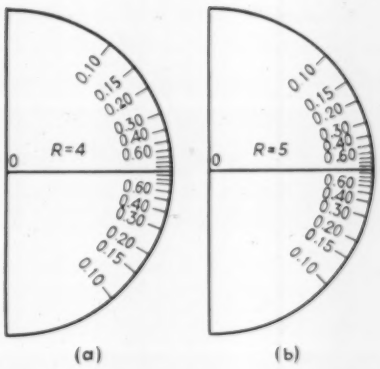

Fig. 2. Scales for simplifying hydraulic computations.

It will be found advantageous to draw the diagram on a stiff card cut in the shape of a semicircle. After a little practice it will be found that use of the diagram will effect considerable time saving especially where there are many small irregular sections to be computed.

Note that the diagram of Fig. 2a is for a ratio of horizontal to vertical scales, *R*, of 4. Fig. 2b shows the diagram for $R = 5$. These are the more common values. It is possible, of course, to draw a diagram for any value of *R*.

HYDRAULIC ELEMENTS OF IRREGULAR CROSS-SECTIONS

1 Correction Ft.	2 Elev. Ft.	3 Top Width Ft.	4 Computation	5 ΔA Sq.ft.	6 A Sq.ft.	7 WP Ft.	8 R Ft.
	507.0						
1	510.0	39	0.19×400	76	76	40	1.90
1 + 2 = 3	516.0	68	53.5×6.0	321	397	71	5.60
3 + 3 = 6	522.0	90	79×6.0	474	871	96	9.07
6 + 5 = 11	526.0	109	99.5×4.0	398	1269	120	10.57
11 + 14 = 25	533.0	109	109×7.0	763	2032	134	15.17
25 + 14 = 39	540.0	109	109×7.0	763	2795	148	18.88

* * *

Madison Controls Heavy Trucking

Trucking on certain streets at Madison, Wis., is prohibited under an ordinance passed in December, 1939. Five locations are specified, on which "it shall be unlawful for any person to operate any motor vehicle truck, except for the purpose of obtaining orders for and delivering or moving supplies or other necessary commodities to or from any place or business or residence fronting on such highways."

Inspecting and Maintaining Building Walls and Roofs

Contents in Brief—Annual spring inspection, recorded by report, sketches and photographs, has been found an essential aid in maintaining the buildings of Yale University. Flat roofs give least trouble. Leaky walls often require complete repointing.

MAINTAINING the extensive buildings of Yale University is guided by complete annual inspections, carried out in early spring, when winter has done its worst. Inspection methods and some maintenance experiences are described by William W. Randolph, assistant to general manager, Yale University Service Bureau, New Haven, in the annual report of the Connecticut Society of Civil Engineers for 1939. Some notes from Mr. Randolph's paper follow.

For inspection the whole group of buildings is divided into sections to each of which is assigned an inspection party of two, a building engineer and a roofing foreman. This party goes over each building systematically from roof to foundation and inspects virtually every inch of roof, flashing, gutters, leaders, cornices, parapets, etc. Inspection of walls is generally done from the ground with the aid of field glasses. Reports are accompanied by 8½x11-in. small-scale floor and elevation diagrams on which defects are spotted, and by photographs of important items that should not be overlooked in budgeting. The reports, which rate the defects in order of importance as (1) necessary repairs, (2) alterations whose savings will return the investment in a few years and (3) desirable but postponable items, are the basis for budget allotment of maintenance funds.

Flat roofs and sloping roofs

Experience at Yale shows that flat roofs are the simplest and cheapest to maintain. The preferred roof covering is of the membrane type, which, when laid with the best of materials and labor on a sound surface, may give a life up to 25 years with minimum upkeep.

Tile and slate pavements laid over built-up roofs of this type often give trouble, usually due to laying the grading mortar bed for the tile over the membrane roofing. Expansion and contraction of the pavement opens the joints between the tiles and tends to strain and ultimately tear the membrane, and water leaking through the pavement saturates the bedding so that freezing in winter and leaching of cement and pitch in summer increases the cracking and clogs the roof leaders. It has been concluded that the grading bed should always be laid below the membrane and the tile preferably set in mastic; when set in mortar this should be 1:1:6 lime-cement-sand mix, and 8 to 12-ft. squares should be separated from the adjoining areas by a wider joint filled with mastic to take care of expansion.

Sloping slate roofs should have brass or bronze snow guards where near sidewalks, to protect passers from snow slides, especially as these may carry loose slates along with them. To keep broken slates from sliding off, the snow guards are advantageously fitted with small-mesh non-corrosive screening.

Metal roofs often are bothersome because of condensation. The trouble is reduced by having an insulating layer between the metal and the roof slab, and experience with various materials for this purpose has led to specifying only the best grade of cork. Some other insulating materials have been found to rot and soften, especially where a leak developed in the roof covering.

Leaking masonry walls

Wall leakage has been found to be an occasional problem in old buildings, more commonly in newer ones. Symptoms are damp spots outside or inside, efflorescence, hairline cracking of joints or units, or face scaling. To aid in discovering the points of leakage it is helpful to mark the leaks on scaled floor plans and elevations with dates and other details, and then examine the structure, proceeding from roof to walls. Flat roofs are tested by playing a hose spray against the flashings and by flooding the roof an inch or two deep after plugging the leaders. Flood testing of box gutters and inside leaders is also important. To test the walls a hose line with horizontal sprinkler arm is lowered over the edge of the roof down along the wall and the wall is sprayed to simulate the effect of a heavy rain, starting below the point where the leak appears and drawing the sprinkler up in stages. This method has usually been successful in locating the point of leakage, even where it was at some distance from the resulting damp spot or stain.

In sealing a leaking wall the first step usually is to cut out all old and doubtful mortar joints ¾ in. deep, replace all soft bricks and repoint the joints. It has often been found worth while to cut out and repoint all the joints in the suspected area. Costs run from 30c. to $1 per sq. ft.

Where repointing is done by contract a 2 to 10-year guarantee is asked, covering internal damage as well as the work itself but excluding effects of settlement or vibration. Specifications for contract work call for cutting out joints ¾ in. deep, blowing out loose mortar by water or air, wetting the joint and the adjoining surface, tucking mortar into the joint so that it is filled and compacted, and tooling it to a weathered joint with hard surface. They also provide for cutting out all joints between door and window frames and the masonry as well as all joints of copings and cornices, filling large voids with oakum or lime mortar, and calking with plastic calking compound; in copings and cornices the joints are capped with lead.

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Pan American Highway

MEXICO has budgeted $1,000,000 this year for the road under construction between Mexico City and Suchiate on Mexico's part of the Pan American highway. This road is scheduled for completion early in 1941, Mexico having spent about $4,500,000 on the project since it was started in 1936.

FROM FIELD AND OFFICE

Working problems and time-saving methods . . . Edited by Charles S. Hill

Job-Made Air Conditioners

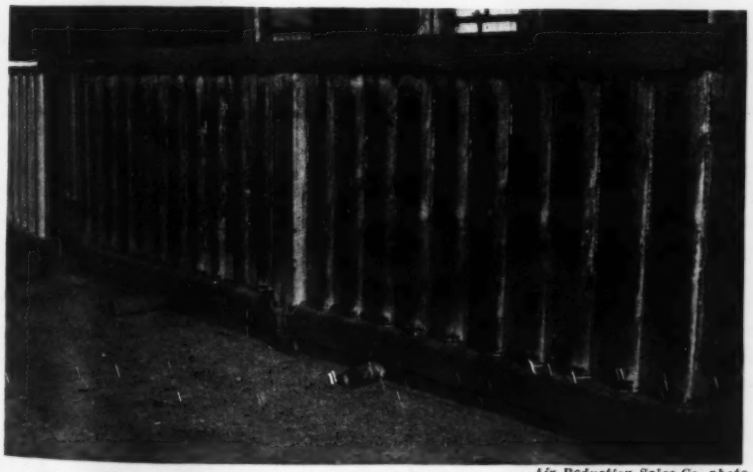
More comfortable living quarters were made possible at Shasta Dam by air-cooling and conditioning apparatus consisting of a wet excelsior pad through which air is drawn by a fan into the rooms to be cooled. The principle is the same as that used at Yuma, Boulder and on other Bureau of Reclamation work in hot climates. However, because of the considerably lower humidity at Shasta the effectiveness of the apparatus depending upon evaporation is considerably higher.

A common form of the device is a thin pad of excelsior through which water drips from a $\frac{3}{16}$-in. copper tube. For a 5-room residence a 2,500-cu.ft. per min. fan driven by a $\frac{1}{4}$-hp motor can draw air through the pad and blow it into some central location in the house at a rate that greatly increases comfort.

• • •

Welded Pipe and Plate Rail

A unique design of steel railing, utilizing tubular vertical stiffening members, is used on the new E. 9th St. bridge at Cleveland, Ohio. The horizontal members at the top and bottom are made of a $\frac{1}{4}$-in. plate, bent and welded to a 7-in. channel. The posts are of $\frac{3}{8}$-in. steel plate, formed and welded along the center. The construction between the posts consists of the 4-in. steel pipe stiffener with $\frac{1}{4}$-in. plate welded between the pipes to form a solid structure. Two railings 195 ft. long, and composed of thirteen sections, 5 ft. by 15 ft., are required. Twelve tons of pipe and sixteen tons of plate material were used on the job, which was fabricated and erected by the Park Iron Works Co., Cleveland.



Air Reduction Sales Co. photo

Welded pipe and plate railing for new Ninth St. bridge in Cleveland, Ohio.

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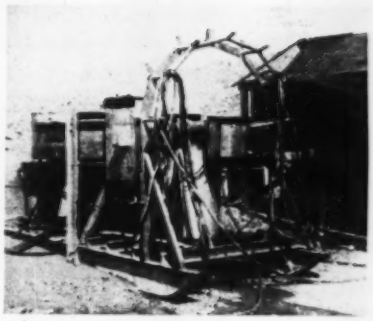
Portable Power Distribution Center

E. N. BANTHIN
Construction Engineer
Cravitz, Wis.

The accompanying illustration shows a portable power distribution center used in connection with electrical equipment on a construction project. Energy was obtained from the utility at 4,000-v. three-phase, 60 cycles and transmitted to this distribution center in a four-wire (1 to ground) selenium rubber covered cable. The power in the distribution center was under the control of an oil switch across the 4,000-v. line ahead of three 100-kva, 4,000/440-v. delta-connected oil-immersed transformers. The 440-v. connections for portable lines where made through two fused disconnects of 30 amperes capacity. A secondary bank of three



Electric power distribution unit for field use.

400/220-v. delta-connected oil-immersed transformers of 30 kva were available for portable lines through fuse disconnects and standard four-prong plugs. A small 7.5-kva, 440/110-volt single-phase air-cooled transformer was available for flood-lighting requirements. The entire unit was mounted on skids constructed out of 8-in. H-sections. On one end a welded channel and pipe rack was built for storing the lighter portable lines. All portable lines carried a ground wire and provided for the safety of operations.

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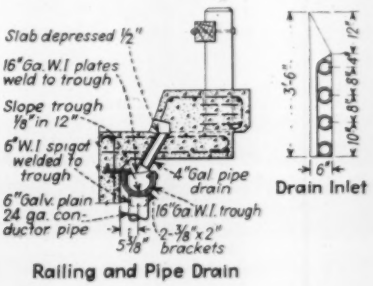
Multiple Gutter Discharge

Reinforcing steel in the floor slab of an overpass on the new railroad line around Shasta Reservoir was



Multiple discharge from bridge gutter avoids interference with reinforcing steel.

left undisturbed by designing the escape for drainage water as a group of 4-in. pipes. This size was selected because it would fit between the $\frac{5}{8}$-in. steel rods laid on 5-in. centers in the floor slab. These 4-in. outlets project through the underside of the bridge deck and discharge into a short trough surmounting the 6-in. down-spout.

BOOK NOTES AND REVIEWS

The month's additions to the engineer's reading and reference list

Early Engineering

ENGINEERS AND ENGINEERING IN THE RENAISSANCE—By the late Wm. Barclay Parsons. 680 pp. Published by The Williams & Wilkins Co., Baltimore, Md. Price $8.

During the latter part of his life the late General William Barclay Parsons devoted much time and study to the engineers of the Renaissance, made an interesting collection of early books of the period (now in the New York Public Library) and, before his death in 1932, had accumulated a large amount of material for a book on the engineers and engineering of this period. The present volume is thus a posthumous publication, General Parsons' manuscript having been sorted and arranged by J. S. Newberry of Boston and carried through the press by Miss Ethel Paine of New York.

The name Renaissance is commonly used in referring to that development of the late 15th and early 16th centuries which, beginning in the city states of Northern Italy, was carried to France through the Franco-Italian wars, and was also reflected in Great Britain and in Germany.

Apparently General Parsons was attracted to this period, as so many have been, by his deep interest in the many accomplishments of that remarkable universal genius of the time, Leonardo da Vinci. The first eighty-odd pages of his book are devoted to an account of those portions of Leonardo's well-known "Note Books" which deal with scientific and mechanical ideas and devices.

The second section of the volume is devoted in large part to the great spectacle of the year 1585—the moving of the Vatican obelisk to its present position in front of St. Peter's at Rome. The mining revival in the 16th Century is also outlined and is based largely on Agricola's *De re metallica* which is widely known through the beautifully printed translation and notes by ex-President and Mrs. Hoover.

It is obvious that in such an unsettled period as the 15th Century, when wars and rumors of wars were everyday affairs, there could be little or no public demand for civil works. That section of General Parsons' book dealing with the feeble beginnings of municipal engineering, therefore, carries the story much beyond the usual date set for the close of the Renaissance. He uses as his example the city of Paris, and reports in great detail on the development of its streets, water supplies, sewers, building and labor regulations, etc. Most of this material is of far from ready access and must have been the result of a tremendous amount of search and research.

Similarly, in hydraulic engineering there is a review of early work in Northern Italy—the Arno and, particularly, the canal constructions near Milan—which is carried forward, with a discussion of the famous French canals, through the late 16th and into the 17th centuries. This study also reflects the detailed search which General Parsons made of original, early records, particularly those relating to the origin of the canal lock and the conditions under which it was developed.

The longest section in the book deals with structural engineering and includes not only such famous structural and architectural triumphs as the domes of the cathedrals of St. Peter's at Rome and of Santa Maria at Florence, but also notes on a number of well-known Italian and French bridges of the 16th and 17th centuries. The book is well illustrated throughout with cuts and half-tones totalling over 200 in number.

Needless to say, the engineer who has been interested in the history of his profession—as well as the historian who is interested in the part played by the engineer in the early days of modern engineering—will find in this volume in convenient form some material with which he is already familiar through other texts and translations. He will also find, however, much data and detail that is not readily available, particularly in English. Unfortunately *Engineers and Engineering of the Renaissance* is an uncompleted study—it ends in the middle of a paragraph where its author put down his pen for the last time. Perhaps the most disappointing omission of the book is its failure to convey any very clear picture of the status and position of the engineer in the life of his day—his relationship to the economic and social life of his times. This is the more surprising when we recall that General Parsons always insisted that the true measure of merit in engineering accomplishment is the completeness with which engineering design meets the economic and social needs of its day. Furthermore, when we recall that the Renaissance may be said to have marked the birth of engineering as a separate and distinct profession, this omission becomes even more marked.

We know that General Parsons was working to the last adding to and revising his manuscript, and it seems probable that he would postpone, until the last bit of data had been collected, the preparation of his summary and conclusions, his analysis and interpretation of the position and influence of the engineer and of engineering in the Renaissance. It would appear, therefore, that his death has thus deprived us of what would have crowned and completed his labor of love—a masterful statement by a keen student of and a pastmaster in the analysis of trends and developments in the profession to which he devoted his life and to which he made such notable contributions.—*Reviewed by* JAMES K. FINCH, *Renwick Professor of Civil Engineering, Columbia University, New York.*

Report Writing

WRITING THE TECHNICAL REPORT —By J. Raleigh Nelson. 373 pp. Published by the McGraw-Hill Book Co., Inc., New York and London. Price $2.50.

Prof. Nelson in his text endeavors to supply a useful tool to both the student who approaches report writing in the abstract and the practitioner who finds himself faced with a particular report-writing problem. Fundamental principles are set down in detail—possibly in too much detail for the busy engineer—and good use is made of examples taken from a variety of technical reports. The usefulness of such a text goes beyond report writing; the principles set

forth are equally applicable to the writing of papers for engineering societies or for descriptive articles for technical journals.

Influence Lines

INFLUENCE LINES—By David S. Stewart. 215 pp. Published by Constable & Co., Ltd., London. Obtainable from The Engineers Book Shop, 168 E. 46 St., New York. Price $4.50.

It is rather unusual to find an entire book devoted to the subject of influence lines with no reference whatsoever to their applications in the field of statically indeterminate structures. Moreover, it is surprising that the qualitative significance of influence lines receives little or no mention. Many American engineers and educators believe that a simple sketch of an influence line which shows the shape and load divides, if any, is sufficient to guide the placing of live loads, which, after all, is the chief function of an influence line. There are certain cases of unusual systems of concentrated loads, or infrequently used wheel loadings, for which the familiar tables of moments or equivalent uniform loads for moment and shear have not been developed. In these cases, influence diagrams with accurately calculated ordinates may be of some value. In other words, the "quantitative" influence line then has some significance. Where continuous girder spans must be analyzed for the effect of a system of moving concentrated loads, quantitative influence lines are a great help, particularly in getting maximum negative moments over support. However, the author, as noted before, does not take up the case of statically indeterminate structures.

The author has presented very clearly a detailed discussion of the use of influence lines in calculating maximum moments and shears in simple girder spans and maximum stresses in a variety of trusses. The book will be of help to those engineers who prefer the influence line method for the actual calculation of values in the various types of elementary structures used by the author in his illustrations. The book will also be of value to beginning students who would like to refer to a more detailed treatment of the subject than that usually given in courses devoted to elementary theory of structures.

In conclusion, the reviewer would like to state that the training of engineering students in the United States differs somewhat from the training in Great Britain and that it is only natural that a difference of opinion will exist as to the relative importance given to the subject of influence lines in our respective technical curricula. —*Reviewed by* HAROLD E. WESSMAN, *Professor of Structural Engineering, New York University.*

Data for Surveyors

SURVEYING AND BOUNDARIES—Second Edition. By Frank E. Clark. 896 pp. Published by The Bobbs-Merrill Co., Indianapolis. Price $6.

Contrary to the general opinion that a land surveyor is a sort of skilled axe-and-shovel compassman, many of the more progressive land surveyors have studied law and have been admitted to the bar in order to keep abreast of the joint legal and technical problems found in their work. F. E. Clark, author of "Surveying and Boundaries," the second edition of which has recently appeared, is one of these combined surveyors and lawyers. The new edition of his book contains the legal information which the land surveyor needs in very easily usable form.

The land surveyor needs a textbook on the theory and practice of surveying operations. There are many good textbooks available. He needs to have access to the original notes of the original surveyors. These are harder to secure but can generally be had. He needs to know the original instructions under which the original surveys were conducted so that the field notes and plats may be correctly interpreted. This information was not made generally available for the older surveys until the appearance of Stewart's, "The Public Land Surveys," except in connection with the more recent work in the public land states by the General Land Office.

The land surveyor also needs to be familiar with the legal aspects of the determination of land boundaries. The first book of the sort was Professor Hodgman's work compiled for a committee of the Michigan Engineering Society about fifty years ago.

Clark's first edition of "Surveying and Boundaries" was another book which brought valuable legal information to the surveyor. Skelton's "Legal Elements of Boundaries" then appeared. Then a law volume, "Land Titles," by R. G. Patton really added to the available published material a surveyor needed in cases likely to reach trial in court.

The second edition of Clark's book is very much improved. It combines the latest legal applications with profuse references to pertinent court decisions. It recognizes the need for complete preliminary study of the original surveys. It quotes the most recent circular of the U. S. General Land Office and explains the points so excellently covered in that document.

This edition is thoroughly revised so that it is a reliable guide to the law of land surveying. It is especially strong on riparian matters, as was the first edition. Chapters on "Identification of Tract"; Evidence of Location of Corners"; "Meaning of Words in Descriptions"; "Answers to Questions"; and "State Laws and Decisions" cover points not generally available to surveyors in text books. The material on coordinate surveying, highway right-of-way surveys and adverse possession is a valuable contribution to current surveying literature.—*Reviewed by* J. S. DODDS, *Professor in Civil Engineering Iowa State College, Ames, Iowa.*

MISCELLANEOUS NOTES ON BOOKLETS AND REPRINTS

TIMBER PILES AND CONSTRUCTION TIMBER is the subject of Manual of Engineering Practice No. 17 published by the American Society of Civil Engineers, 33 West 39th St., New York City. Price, 70¢ to nonmembers.

REVISED SPECIFICATIONS FOR CUT-BACK ASPHALT, adopted by the Asphalt Institute in December of last year, have been published by the Institute (801 Second Ave., New York) as "Construction Series No. 51."

A VARIETY OF INFORMATION on reinforced concrete is contained in a pamphlet recently put out by the Concrete Reinforcing Steel Institute, Builders Building, Chicago, under the title of "A Manual of Standard Practice for Reinforced Concrete Construction." The pamphlet contains standard specifications for reinforcing bars of various grades, for con-

crete and for placing reinforcing steel. Also included is a code of standard practice with respect to reinforcing steel. Tables and charts include standard loadings and design data for concrete joist construction.

CONTRACTORS AND ENGINEERS who are beginning to think about the preparation of their income tax will find a lot of valuable information in "Your Income Tax" by J. K. Lasser, published by Simon & Schuster, New York, price, $1.

TWO SUPPLEMENTS to *Wood Structural Design Data*, Nos. 6 and 7, have been published by the National Lumber Manufacturers Association, Washington, D. C. They are entitled "Timber Connectors, Design and Load Data," and "Stud Walls, Safe Axial Loads."

AIRPORT DRAINAGE, an illustrated pamphlet on methods of installing underdrains for landing fields, has been published by the Clay Products Association, 111 W. Washington St., Chicago. There is no charge for this pamphlet.

CONTINUOUS CONCRETE BRIDGES is the subject of a pamphlet published by the Portland Cement Association, 33 W. Grand Ave., Chicago. Methods for designing such bridges are set forth in text, diagrams and nomographs. Limited free distrubution.

FOR THOSE INTERESTED in welded building construction, the American Institute of Steel Construction, 101 Park Ave., New York, has published recommended principles, tentative requirements, and tentative standards for welded connections for tier buildings prepared by a special committee of engineers and architects.

THE DELAWARE RIVER BASIN is the subject of three pamphlets put out by the Interstate Commission on the Delaware River Basin, Broad St. Station Building, Philadelphia, Pa. The pamphlets are as follows: "Planned Progress in Pollution Control," "Physical Facts, a Graphic Compendium Containing Maps and Charts," and "Flood Volumes."

FEDERAL VALUATION OF RAILROADS is the subject of a paper by Edward F. Wendt, consulting engineer, Pittsburgh, Pa., that has been reprinted from Bulletin 412 of the American Railway Engineering Association (59 E. Van Buren St., Chicago, Ill.). The paper briefly reviews the history of railroad valuation work and sets forth the significant orders of the Interstate Commerce Commission and court decisions relating to railroad valuation.

THE GLUED LAMINATED WOODEN ARCH is the subject of Technical Bulletin No. 591 U. S. Department of Agriculture. Methods of construction are described and the results of extensive test by the Forest Products Laboratory are given. For sale by the Superintendent of Documents, Washington, D. C. Price, 20¢.

A LARGE AMOUNT OF INFORMATION on the uses and methods of handling brass pipe is contained in a pamphlet issued by the Copper and Brass Research Association, 420 Lexington Ave., New York City.

NEW ENGINEERING BOOKS

THE CONSTRUCTION OF ROADS AND PAVEMENTS—By Thomas Radford Agg. 5th Edition. 483 pp. Published by the McGraw-Hill Book Co., Inc., New York and London. Price $4.

MODEL TESTS OF BOULDER DAM—Boulder Canyon Project. Final Reports. Part V—Technical Investigations. Bulletin 3. 402 pp. Paper-bound copies, $1.50; cloth-bound copies, $2.

CONSTRUCTION ESTIMATES AND COSTS—By Harry E. Pulver. 653 pp. Published by McGraw-Hill Book Co., Inc., New York. Price $5.

THE MODERN RAILWAY—By Julius H. Parmelee. 730 pp. Published by Longmans Green & Co., New York City. Price $4.

BRICK ENGINEERING—By Harry C. Plummer and Leslie J. Reardon. 400 pp. Published by Structural Clay Products Institute, Washington. Price $4.

INTERIOR ELECTRIC WIRING AND ESTIMATING—By Albert Uhl, Arthur L. Nelson and Carl H. Dunlap. 342 pp. Published by the American Technical Society, Chicago, Ill. Price $2.50.

STAIR BUILDING—By Gilbert Townsend. 200 pp. Published by the American Technical Society, Chicago, Ill. Price $2.

HOW TO DESIGN AND INSTALL PLUMBING—By A. J. Matthias, Jr. 388 pp. Published by the American Technical Society, Chicago. Price $3.

STAHLBAU-KALENDER 1940—591 pp. Published by Wilhelm Ernst & Sohn, Berlin. Bound 3.35 RM.

DER DURCHLAUFENDE BALKEN AUF ELASTISCH DREHBAREN UND ELASTISCH SENKBAREN STUTZEN—By Alfred Manger. 170 pp. Published by Leemann & Co., Zurich. Price Fr. 12.

INDUSTRIAL SURVEYS AND REPORTS—By Walter Rautenstrauch. 189 pp. Published by John Wiley & Sons, Inc., New York; Chapman and Hall, Ltd., London. Price $2.50.

LEGAL ASPECTS OF ENGINEERING—By Walter C. Sadler. 631 pp. Published by John Wiley & Sons, Inc., New York; Chapman & Hall, London. Price $4.

HEATING, VENTILATING, AIR CONDITIONING GUIDE 1940—18th Edition. 1088 pp. Published by the American Society of Heating and Ventilating Engineers, 51 Madison Ave., New York City. Price $5.

PUBLIC BUILDINGS—697 pp. Architecture under the Public Works Administration, 1933-39. By C. W. Short and R. Stanley Brown. For sale by the Supt. of Documents, Washington. Price $2.50.

ECONOMIC STUDIES OF MARYLAND—Parts III and IV. Copies obtainable from the Maryland State Planning Commission, 17 Latrobe Hall, The Johns Hopkins University, Baltimore, Md. Price 25c.

AULAS DE TECNICA FISCAL E CONTABILIDADE—Estado de Minas Gerais. 892 pp. Published by the Estado de Minas Gerais, Belo Horizonte, Brazil.

MATHEMATICAL METHODS IN ENGINEERING—By Theodore V. Karman and Maurice A. Biot. 505 pp. Published by McGraw-Hill Book Co., Inc., New York and London. Price $4.

PROCEEDINGS, 1939, AMERICAN ROAD BUILDERS' ASSOCIATION—618 pp. Published by the American Road Builders' Association, National Press Bldg., Washington, D. C. Price $10.

MASTER SPECIFICATIONS FOR RECONDITIONING—228 pp. Published under supervision of Home Owners' Loan Corporation, Appraisal and Reconditioning Division, Washington, D. C. Third Edition. Price 30c.

ELEMENTARY SURVEYING—By Warren C. Taylor. 236 pp. Published by International Textbook Co., Scranton, Pa. Price $2.

SEVEN PLACE NATURAL TRIGONOMETRICAL FUNCTIONS—By Howard Chapin Ives. 222 pp. Published by John Wiley & Sons, Inc., New York; Chapman & Hall, Ltd., London. Price $2.50.

PRINCIPLES OF INDUSTRIAL MANAGEMENT FOR ENGINEERS—By L. P. Alford. 531 pp. Published by The Ronald Press Co., 15 E. 26th St., New York City. Price $4.50.